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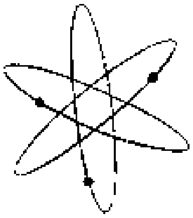
HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT® by DAYSTROM



DC OSCILLOSCOPE

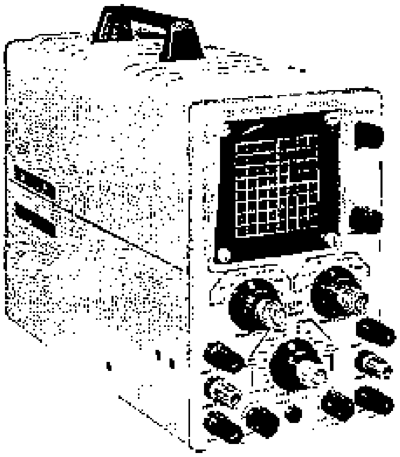
MODEL IO-10

Assembly
and
Operation
# of the

HEATHKIT by DAYSTROM

DC OSCILLOSCOPE

MODEL IO-10



HEATH COMPANY,
BENTON HARBOR
MICHIGAN

a subsidiary of
DAYSTROM, INCORPORATED

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SPECIFICATIONS

VERTICAL AND HORIZONTAL CHANNELS (Identical)

Bandwidth:	DC to 200 kc (2 db point).
Sensitivity:	.1 V (peak to peak) per 1/4" (uncalibrated).
Attenuator:	3-position, compensated type.
Gain Control:	Continuously variable.
Input Impedance:	3.6 megohms shunted by 35 μμf.
Coupling:	Either AC or DC, selected with the input attenuator switch.
Centering:	Any portion of a 2" x 2" trace may be positioned on any portion of the CR tube screen.
Polarity	A positive signal applied to the vertical channel will deflect the beam up, a positive signal applied to the horizontal channel will deflect the beam to the left.
Relative Phase Shift Between Channels:	Less than 5 degrees.

SWEEP GENERATOR

Recurrent Type:	Linear saw-tooth produced by multivibrator type generator.
Sync Provisions:	Either internal or external sync may be switch selected. The sync level is automatically maintained over a range of 1/4" to 2" vertical trace height.
Frequency Coverage:	From 5 cps to 50 kc in four overlapping ranges. Lower sweep rates may be obtained by adding capacity to the "External Capacity" binding post on the front panel.
Blanking:	The retrace (or flyback) cycle is blanked in conjunction with the internal sweep generator.

GENERAL

CR Tube:	Type 3RP1, medium persistence, green trace.
Power Supplies:	Transformer operated, fused. The B+ supply uses a 6X4 tube as a full-wave rectifier. The high voltage supply uses a 1V2 tube and the bias supply uses a silicon rectifier in half-wave circuits. Critical voltages are regulated with VR tubes.

Input Connections:	Vertical and horizontal inputs are 5-way binding posts, with 3/4" spacing. External sync and external capacity are also 5-way binding posts located on the front panel.
Net Weight:	12-1/2 lbs.
Shipping Weight:	14 lbs.
Dimensions:	8-5/8" high x 4-5/8" wide x 12-3/4" deep, overall.

INTRODUCTION

The Model IO-10 Oscilloscope was designed as a small compact instrument containing identical DC coupled vertical and horizontal amplifiers. DC coupling in the amplifier channels of the IO-10 Oscilloscope allows it to be used with low frequency phenomena from over 200 kc down to DC. The small physical size of the IO-10 tends to alleviate workshop congestion and permits the oscilloscope to be moved about with ease. Also, the negligible phase shift between the vertical and horizontal amplifiers makes the IO-10 ideal for specialized uses such as computer read-out

CIRCUIT DESCRIPTION

Amplifier Circuit

Since the vertical and horizontal amplifier circuits are identical, only the vertical circuit will be discussed.

A signal applied to the VERTical INput terminals is coupled to the grid of V12A via the frequency compensated attenuator network. Capacitor C1 acts as a blocking capacitor in the AC positions of the VERTICAL switch.

Tube V12A is an input cathode follower, a zero DC reference is established in the V12A cathode circuit by adjusting the Vertical Balance control. The signal from V12A is coupled through Vertical Gain control R8 to V1A and V1B, the push-pull driver stage. (Common cathode coupling is used to apply the signal from V1A to V1B.) From V1A and V1B the signal is routed, via parasitic suppressors R16 and R18, to push-pull output stage V2A and V2B. Here the signal is again amplified and is applied to the vertical plates of the CR tube, where it provides balanced deflection of the electron beam.

Simultaneously, the push-pull output of the horizontal amplifier is applied to the horizontal plates of the CR tube, creating a complete pattern on the CR tube face.

Vertical centering is accomplished by adjusting control R13 which changes the bias at the grid of V1A. The effect of this change is coupled through the push-pull driver and output stages to the CR tube.

Sweep Generator

The horizontal sweep waveform is created by V4A and V4B, the sweep multivibrator. The sweep timing capacitor that is switched into the cathode circuit of V4B and the position of the Fine Frequency control determine the horizontal frequency. The horizontal sweep waveform is made linear, in the form of a sawtooth, by the circuit of V3B and the neon lamp. The Sweep Position control is adjusted to provide the proper voltage reference at the center of the sawtooth waveform.

V3A, the sync cathode follower, receives either an EXTernal SYNChronizing signal from the binding post or an INTernal SYNChronizing signal from the vertical amplifier. The synchronizing signal is applied to the sweep multivibrator.

If the linear output of the swaep generator is not desired for a special application, a signal of any shape may be applied to the HORizontal INput terminals. This external signal will then be amplified in the horizontal channel and applied to the horizontal plates of the CR tube.

Powar Supplies

The fused power transformer feeds the IO-10 Power Supply. The full-wave B+ supply contains V10, V9, and four filter capacitor sections. The half-wave B- supply contains the silicon diode rectifier, V11, and three filter capacitor sections. Tube V8, with the high voltage filter and the bleeder network, supply operating voltages for the CR tube.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

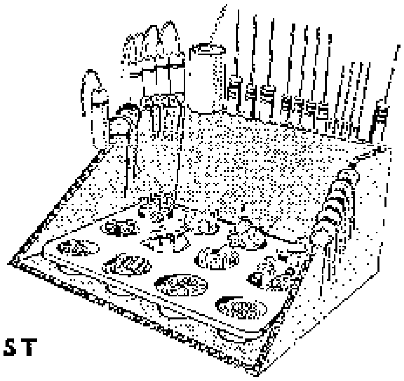
UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please reed the REPLACEMENT section and supply the information called for therein. Include all inspection slips in your letter to us.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started.

1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade, a small screwdriver with a 1/8" blade; long-nose pliers, wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-3	9	100 Ω 1/2 watt (brown-black-brown)
1-9	2	1000 Ω 1/2 watt (brown-black-red)
1-20	1	10 KΩ 1/2 watt (brown-black-orange)
1-21	3	15 KΩ 1/2 watt (brown-green-orange)
1-22	3	22 KΩ 1/2 watt (red-red-orange)
1-25	2	47 KΩ 1/2 watt (yellow-violet-orange
1-26	3	100 KΩ 1/2 watt (brown-black-yellow)
1-27	1	150 KΩ 1/2 watt (brown-green-yellow)
1-35	5	1 megohm 1/2 watt (brown-black-green)
1-44	3	2200 Ω 1/2 watt (red-red-red)
1-87	2	330 KΩ 1/2 watt, 5% (orange-orange-yellow-gold)
1-88	2	36 KΩ 1/2 watt, 5% (orange-blue-orange-gold)
1-132	1	20 KΩ 1/2 watt, 5% (red-black-orange-gold)
1A-9	2	10 KΩ 1 watt (brown-black-orange)
1A-26	2	15 KΩ 1 watt (brown-green-orange)
1A-37	1	3.3 megohm 1 watt (orange-orange-green)
1B-3	2	10 KΩ 2 watt (brown-black-orange)
1B-11	4	22 KΩ 2 watt (red-red-orange)

PART No.	PARTS Per Kit	DESCRIPTION
Resistors (cont'd)		
1B-17	1	6800 Ω 2 watt (blue-gray-red)
2-129	2	3.3 megohm 1/2 watt, 5%
3G-6	1	330 Ω 7 watt wire-wound
3G-12	2	700 Ω 7 watt wire-wound
3J-19	2	2000 Ω 10 watt wire-wound
Controls-Switches		
10-10	2	20 KΩ linear control
10-17	1	1 megohm linear control
10-57	2	10 KΩ linear control, tab mounting
10-58	1	100 KΩ linear control, tab mounting
10-60	1	500 KΩ linear control, tab mounting
19-40	1	500 KΩ linear control with on-off switch
63-200	1	9-position switch with 3 megohm control
63-201	2	6-position switch with 5 KΩ control
Capacitors		
20-1	2	47 μμf silver mica
20-43	2	390 μμf mica
21-21	1	200 μμf disc ceramic
21-31	3	.02 μfd disc ceramic
21-36	1	.002 μfd disc ceramic
21-42	1	.01 μfd disc ceramic, 1600 V
23-11	2	.1 μfd tubular 600 V
23-28	1	.1 μfd tubular 200 V
23-29	2	.1 μfd tubular 1200 V
23-56	1	.2 μfd tubular 200 V

Capacitors (cont'd.)

PART No.	PARTS Per Kit	DESCRIPTION
25-108	1	100-100-100 μfd at 150 V electrolytic
25-109	1	40-40-30-40 μfd at 400 V - 350 V - 250 V - 150 V electrolytic
27-19	1	1 μfd Mylar* (polyester film)
31-18	2	Dual trimmer

Insulators-Wire

PART No.	PARTS Per Kit	DESCRIPTION
73-2	1	3/4" rubber grommet
73-3	4	1/2" rubber grommet
73-4	8	5/16" rubber grommet
73-5	1	Cushion strip
75-24	1	Line cord strain relief insulator
341-1	1	Length black test lead
341-2	1	Length red test lead
343-3	1	Length shielded cable
344-1	1	Length hookup wire
344-13	1	Length hi-voltage insulated wire
346-1	1	Length insulated sleeving

Sheet Metal Parts

PART No.	PARTS Per Kit	DESCRIPTION
90-148	1	Cabinet
200-M266	1	Chassis
203-206F374	1	Front panel
204-M323	1	Panel mounting bracket, left
204-M324	1	Panel mounting bracket, right
204-M325	1	Transformer mounting bracket
204-M326	1	Rear panel bracket
204-M327	1	Rear panel support bracket
204-M349	1	Control mounting bracket
206-131	1	CR tube shield
210-12F	1	Bezel

Hardware

PART No.	PARTS Per Kit	DESCRIPTION
250-2	2	3-48 x 5/16" RHMS
250-18	4	8-32 x 3/8" RHMS
250-26	7	6-32 x 5/8" BHMS
250-83	2	#10 x 1/2" self-tapping screw
250-89	28	6-32 x 3/8" BHMS
250-136	20	3-48 x 1/2" FHMS
252-1	22	3-48 nut
252-3	37	6-32 nut
252-4	4	8-32 nut
252-7	7	Control nut
252-22	4	6-32 speednut

*DuPont Registered Trademark

Hardware (cont'd)

PART No.	PARTS Per Kit	DESCRIPTION
252-32	1	Speednut (for neon lamp)
253-10	7	Control flat washer
254-1	35	#6 lockwasher
254-2	4	#8 lockwasher
254-4	4	Control lockwasher
254-7	26	#3 lockwasher
255-2	4	#6 x 3/16" spacer
255-29	20	#3 x 7/32" spacer
259-1	7	#6 solder lug
259-10	3	Control solder lug

Tubes-Lamp

PART No.	PARTS Per Kit	DESCRIPTION
411-25	2	12AU7 tube
411-59	1	OA2 tube
411-64	1	6X4 tube
411-65	1	1V2 tube
411-73	2	12BH7 tube
411-121	3	6BS8 tube
411-140	1	OC2 tube
411-142	1	3RP1 CR tube
412-13	1	Neon pilot lamp

Connectors-Terminal Strips-Sockets

PART No.	PARTS Per Kit	DESCRIPTION
70-5	1	Banana plug sleeve, black
70-6	1	Banana plug sleeve, red
75-17	12	Binding post insulator
260-1	2	Alligator clip
427-3	6	Binding post base
438-13	2	Banana plug
100-M16B	4	Binding post cap, black
100-M16R	2	Binding post cap, red
431-10	2	3-lug terminal strip
431-14	1	2-lug terminal strip
431-16	1	2-lug terminal strip
431-35	1	7-lug terminal strip
431-38	6	3-lug terminal strip
434-15	3	7-pin tube socket
434-16	8	9-pin tube socket
434-41	1	12-pin tube socket
481-1	1	Capacitor mounting wafer, metal
481-3	1	Capacitor mounting wafer, phenolic

Knobs

PART No.	PARTS Per Kit	DESCRIPTION
462-36	3	Red knob, dual control front section
462-53	3	Black knob, dual control rear section
462-82	4	Black knob, small

PART No.	PARTS Per Kit	DESCRIPTION
Miscellaneous		
54-105	1	Power transformer
57-23	1	Silicon rectifier, K-200
89-1	1	Line cord
211-4	1	Handle
261-4	4	Rubber feet
Miscellaneous (cont'd)		
414-8	1	Graticule
414-9	1	Green plastic grid screen
421-1	1	1-1/2 ampere 3AG fuse
423-2	1	Fuse holder
331-6		Solder
595-346	1	Manual

PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT® equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion malfunction due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 25 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron then this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, the wire used in construction of this kit is the type with colored insulation (hookup wire). The larger, high voltage, insulated wire is used only where it is called for in a construction step. In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the step.

2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.

3. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be cut to proper length before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points.

4. Wherever there is a possibility of bare leads shorting to other parts or to the chassis, the leads should be covered with insulating sleeving. Where the use of sleeving is specifically intended, the phrase "use sleeving" is included in the associated construction step. In any case where there is the possibility of an unintentional short circuit, sleeving should be used. Extra sleeving is provided for this purpose.

5. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.

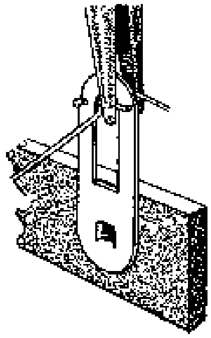
6. Position the work, if possible, so that gravity will help to keep the solder where you want it.

7. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

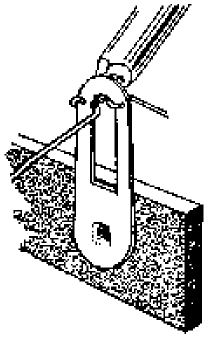
8. Thus place the solder against the heated terminal and it will immediately flow over the joint, use only enough solder to thoroughly "wet" the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

9. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

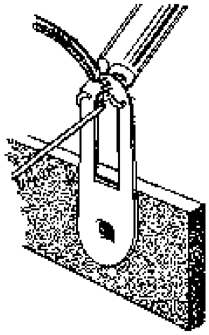
A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth bright appearance.



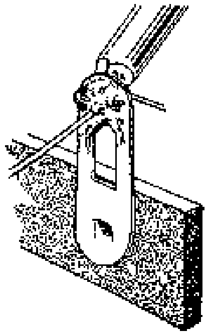
CRIMP WIRES



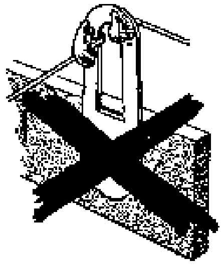
HEAT CONNECTION



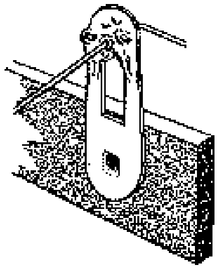
APPLY SOLDER



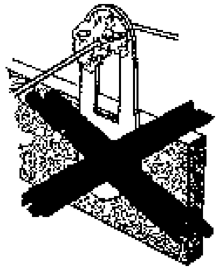
ALLOW SOLDER TO FLOW



COLD SOLDER JOINT CONNECTION INSUFFICIENTLY HEATED



PROPER SOLDER CONNECTION



COLD SOLDER JOINT CONNECTION MOVED WHILE COOLING

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60 40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered. (In cases where a lead passes through a terminal or lug and then connects to another point, it will count as two leads, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear in the construction step which directs its installation.

STEP-BY-STEP ASSEMBLY

The construction of this compact oscilloscope will start by prewiring the switches, followed by parts mounting and wiring of the front panel assembly. Next, the parts will be mounted on the chassis and then on the rear panel support bracket. Finally, all of these assemblies will be fastened together, and the circuit wiring will be completed.

PREWIRING FREQUENCY SWITCH

Refer to Figure 1 for the following steps.

( ) Place the FREQUENCY switch (#63-200) on your work surface. In referring to switch connections, such as FA4:
The first letter "F" means the FREQUENCY switch.
The second letter "A" means deck "A" of the switch (the deck closest to the front of the switch.)
The number "4" means lug number 4.

NOTE: Keep all leads as short as possible when connecting resistor and capacitors to this switch.

(✓) C10. Connect a 200 μμf capacitor between lugs FA4 (NS) and FA5 (S-1). Keep the body of the capacitor flat against the switch as shown in Figure 1.

(✓) C9. Connect a .002 μfd capacitor between lugs FA4 (S-2) and FA3 (NS). Keep this capacitor close to the switch.

(✓) C8. Connect a .02 μfd capacitor between lugs FA3 (S-2) and FA2 (NS). Again, keep the capacitor close to the switch.

NOTE: Use the large diameter hookup wire only where specifically called for. The small diameter wire should be used in all other steps that call for wire. When preparing a length of hookup wire, strip 1/4" to 3/8" of insulation from each end.

CONNECT A	TO LUG	
(✓) 1-1/2" wire	FA2 (NS)	The other end of each of these wires will be connected later.
(✓) 7-3/4" wire	FB2 (S-1)	
(✓) 1-1/2" wire	FB3 (S-1)	
(✓) 1-3/4" wire	FB4 (S-1)	
(✓) 3" wire	FB5 (S-1)	
(✓) 1-1/2" wire	FB5 (S-1)	

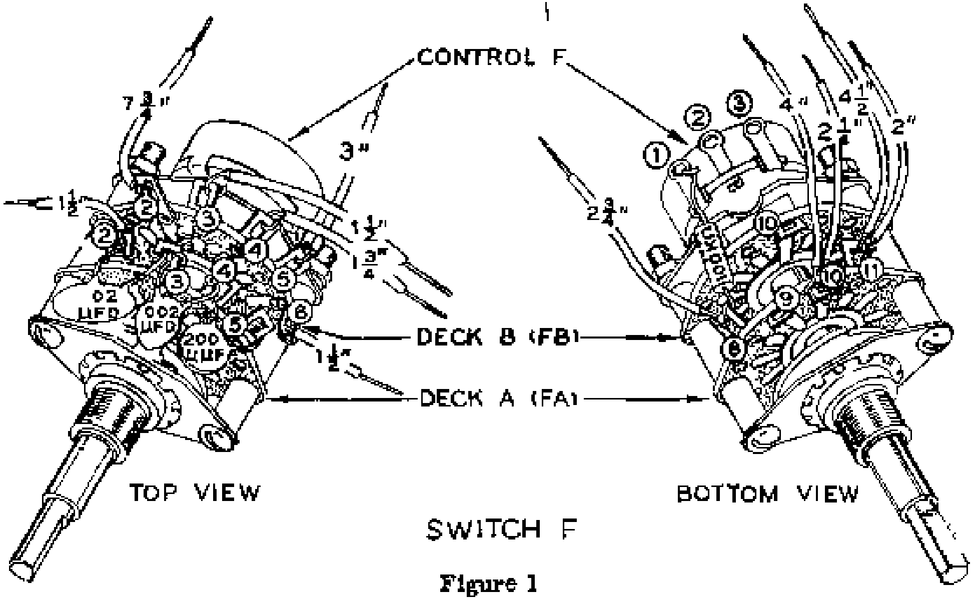


Figure 1

CONNECT A	TO LUG
(✓) 2-3/4" wire	FA8 NS)
(✓) 4" wire	FA10 (NS)
(✓) 2-1/4" wire	FA10 (NS)
(✓) 4-1/2" wire	FA11 (NS)
(✓) 2" wire	FA11 (NS)

(✓) R29. Connect a 100 KΩ (brown-black-yellow) resistor from FA8 (S-2) to lug 1 of control F (S-1).

This completes pre-wiring the FREQUENCY switch. Lugs FA2, FA10, and FA11 are not yet soldered.

PREWIRING THE INPUT TRIMMERS

Refer to Figure 2 for the following steps.

Note that trimmer lugs 1 and 2 are connected to the trimmer with the large insulator under the adjustment screw.

Vertical Trimmer

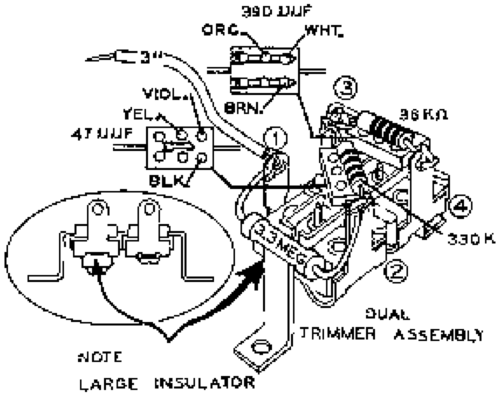
(✓) R4. Select one of the dual trimmers (#31-18) and connect a 3.3 megohm 5% resistor between lug 1 (NS) and lug 2 (NS). Keep the leads of the trimmer components as short as possible and place them as shown in Figure 2.

CONNECT A	FROM	TO
(✓) C4. 47 μμf capacitor	lug 2 (NS)	lug 3 (NS)
(✓) R3. 330 KΩ resistor (orange-orange-yellow-gold)	lug 2 (NS)	lug 3 (NS)
(✓) C2. 390 μμf capacitor	lug 3 (NS)	lug 4 (NS)
(✓) R2. 36 KΩ resistor (orange-blue-orange-gold)	lug 3 (NS)	lug 4 (NS)
(✓) 3" wire	lug 1 (S2)	not connected

Horizontal Trimmer

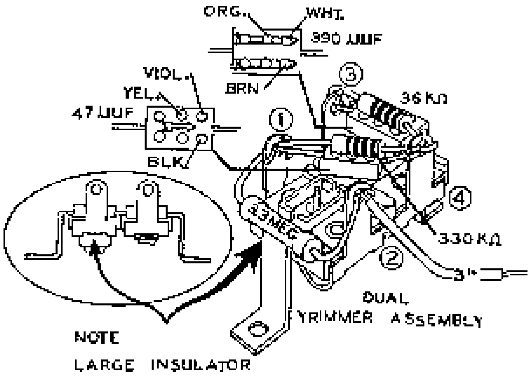
Refer to Figure 2A for the following steps.

( ) R-33. Connect a 3.3 megohm 5% resistor between lug 1 (NS) and lug 2 (NS) of the second dual trimmer.



VERTICAL TRIMMER

Figure 2



HORIZONTAL TRIMMER

Figure 2A

CONNECT A	FROM	TO
(✓) C16. 47 μμf capacitor	lug 1 (NS)	lug 4 (NS)
(✓) R32. 330 KΩ resistor (orange-orange-yellow)	lug 1 (NS)	lug 4 (NS)
(✓) C14. 390 μμf capacitor	lug 3 (NS)	lug 4 (NS)
(✓) R31. 36 KΩ resistor (orange-blue-orange)	lug 3 (NS)	lug 4 (NS)
(✓) 3" wire	lug 2 (NS)	not connected

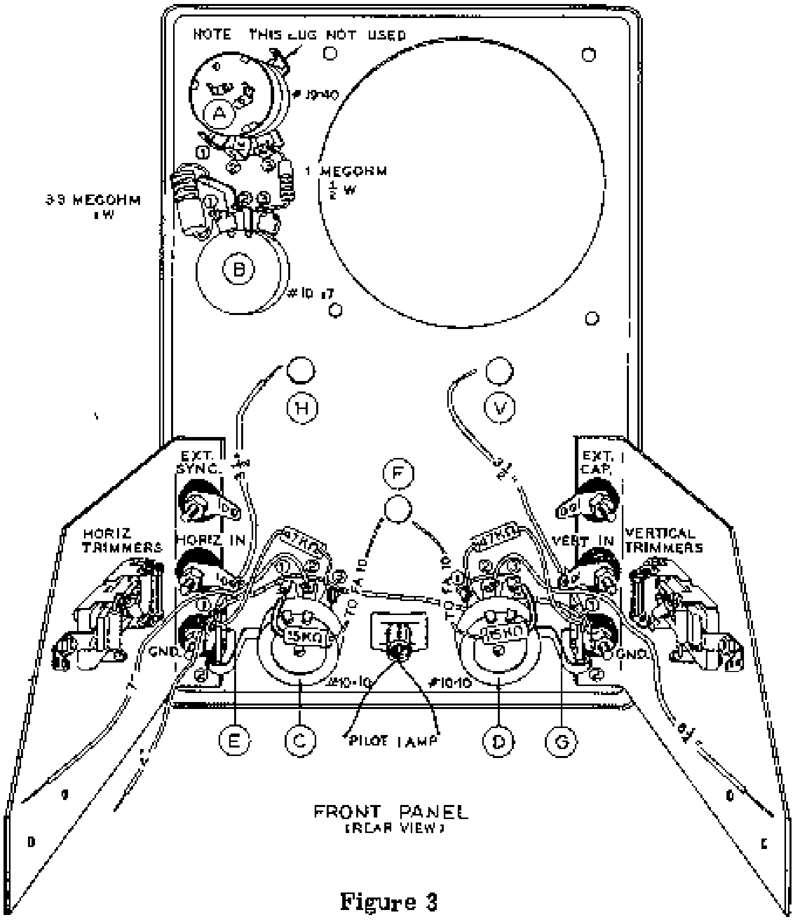


Figure 3

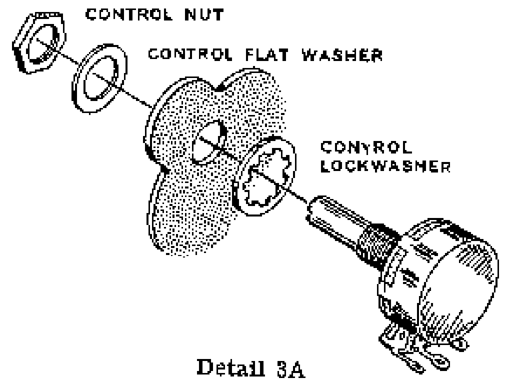
FRONT PANEL ASSEMBLY

Refer to Figure 3 for the following steps.

(✓) R54. Mount the INTENSITY control A (#19-40), using a control lockwasher, control flat washer and a control nut as shown in Detail 3A and Figure 3.

(✓) R56. Mount the FOCUS control B (#10-17). Use a control solder lug (instead of a control lockwasher) and orient as shown in Figure 3.

(✓) R13 and R42. Mount the VERTical CENTering control C (#10-10), and the HORizontal CENTering control D (#10-10). Use a control solder lug (instead of a control lockwasher) under each control and orient the lugs as shown in Figure 3.



Detail 3A

(✓) Place the pilot lamp through its hole from the front of the panel. Fasten it in place with a speednut (#252-32) from behind the panel.

(✓) Place the right panel support bracket in its mounted position. Fasten it in place by mounting the EXT. CAP. (external capacity) binding post as shown in Detail 3B. Orient the solder lug in the direction shown; do not overtighten the nut to avoid breaking the insulators.

(✓) In the same manner, mount the VERT. IN (vertical input) binding post.

( ) Mount the GND binding post. Mount 2-lug terminal strip G under the nut using two #6 lockwashers as shown in Detail 3B.

( ) Now bend the control solder lug from control D down until it lies flat against lug 2 of terminal strip G (NS).

( ) Mount the vertical trimmer using 6-32 x 3/8" screws and 6-32 nuts. Use a #6 lockwasher under the front nut and a #6 solder lug under the rear nut.

IMPORTANT NOTE: Make sure that you mount the correct (vertical) trimmer and that the large insulator is toward the front panel.

( ) Mount the left panel support bracket by installing the EXT.SYNC. binding post. Orient the solder lug as shown in Figure 3.

(✓) In the same manner, mount the HORIZ.IN. (horizontal input) binding post.

(✓) Mount the GND. binding post, with 2-lug terminal strip E under the nut as was done with the other GND. binding post.

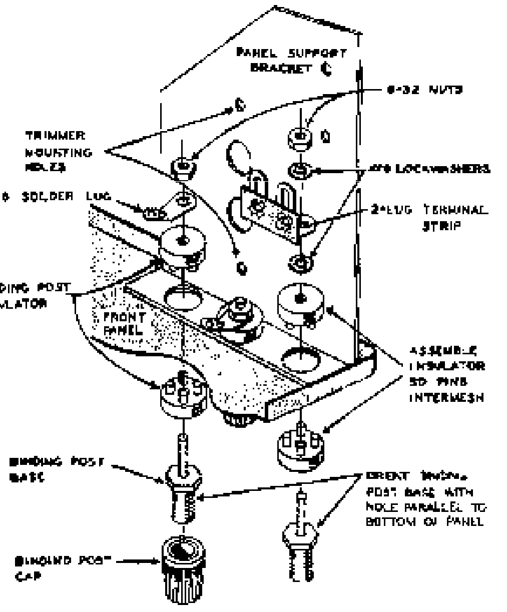
(✓) Now bend the control solder lug from control C down until it lies flat against lug 2 of terminal strip E (NS).

(✓) Mount the horizontal trimmer using 6-32 x 3/8" screws and 6-32 nuts. Use a #6 lockwasher under the front nut and a #6 solder lug under the rear nut.

INITIAL FRONT PANEL WIRING

Refer to Figure 3 for the following steps.

(✓) Connect a 5" hookup wire from lug 1 of terminal strip E (NS) to lug 1 of terminal strip G (NS). Route this wire tightly against the front panel above controls C and D.



Detail 3B

(✓) Strip each end of two 3-1/2" hookup wires. Connect one of these wires to the HORIZ. IN. solder lug (S-1). Leave the other end of the wire unconnected and dressed up toward control B.

(✓) Connect the other 3-1/2" wire to the VERT. IN. solder lug (S-1). Leave the other end of the wire unconnected and dressed up toward the top of the panel.

(✓) Strip each end of a 7" wire. Connect one end to lug 2 of control C (S-1). Route the other end of this wire to the left support bracket and let it hang free toward the rear of the bracket.

(✓) Strip each end of an 8-1/4" wire. Connect one end to lug 2 of control D (S-1). Route the other end of this wire to the right support bracket and let it hang free toward the rear of the bracket.

(✓) Strip each end of a 4" wire and connect one end to lug 1 of terminal strip E (NS). Leave the other end free.

(✓) Cut one lead of a 15 KΩ (brown-green-orange) 1/2 watt resistor to 3/4" and place about 1/2" of sleeving over the lead. Connect this lead to lug 3 of control D (S-1). Temporarily lay the resistor body on control D.

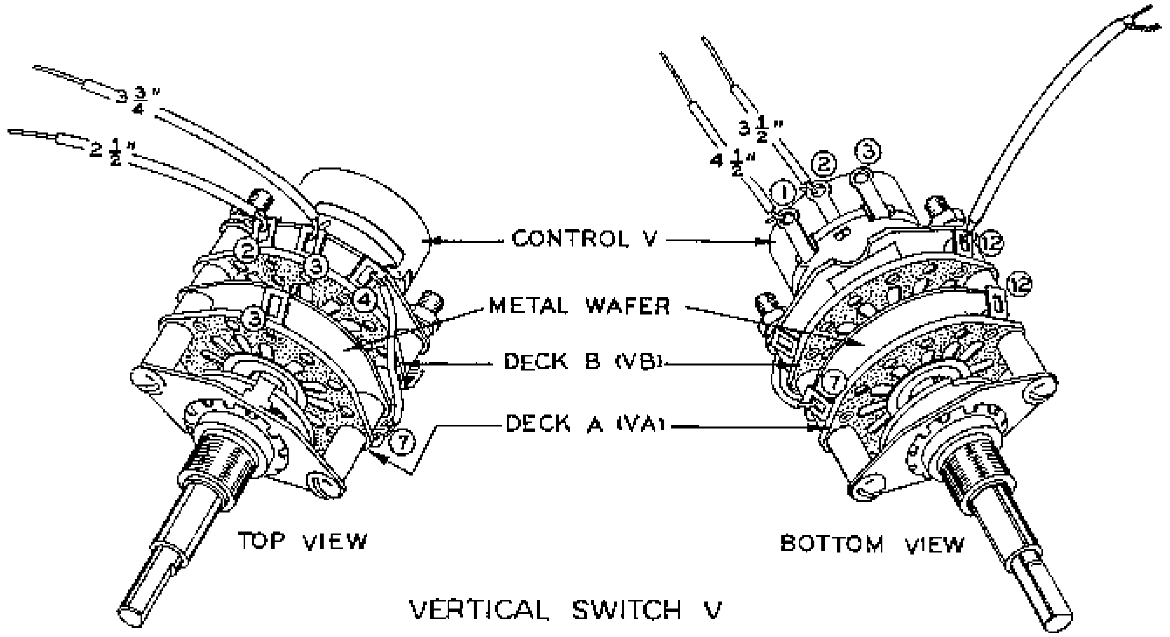


Figure 4

(√) Cut one lead of another 15 KΩ (brown-green-orange) 1/2 watt resistor to 3/4" and place about 1/2" of sleeving over the lead. Connect this lead to lug 1 of control C (S-1). Temporarily lay the resistor body on control C.

( ) Connect a 47 KΩ (yellow-violet-orange) resistor from lug 3 of control C (S-1) to lug 1 of terminal strip E (S-3).

(√) Connect a 47 KΩ (yellow-violet-orange) resistor from lug 1 of control D (S-1) to lug 1 of terminal strip G (S-2).

(√) R55. Connect a 1 megohm (brown-black-green) resistor from lug 3 of control A (S-1) to lug 3 of control B (S-1).

(√) R57. Connect a 3.3 megohm (orange-orange-green) 1 watt resistor from lug 1 of control B (S-1) to the control solder lug above this control (S-1). Place the body of the resistor above the two lugs so that it will clear the cabinet when it is installed later.

PRE-WIRING VERTICAL SWITCH V

Refer to Figure 4 for the following steps.

Select one of the two remaining switches (#63-201).

CONNECT A	FROM LUG	TO
(√) 2-1/2" wire	VB2 (S-1)	not connected
(√) 3-3/4" wire	VB3 (S-1)	not connected
(√) 1-3/4" wire	VB4 (NS)	VA7 (S-1)
(√) 4" shielded cable (See Detail 4A)	VB12 (S-1)	not connected
(√) 3-1/2" wire	lug 2 of (S-1) control V	not connected
(√) 4-1/2" wire	lug 1 of (S-1) control V	not connected

Now make sure that there are no short circuits from the switch lugs and wires to the metal shield between the switch wafers.

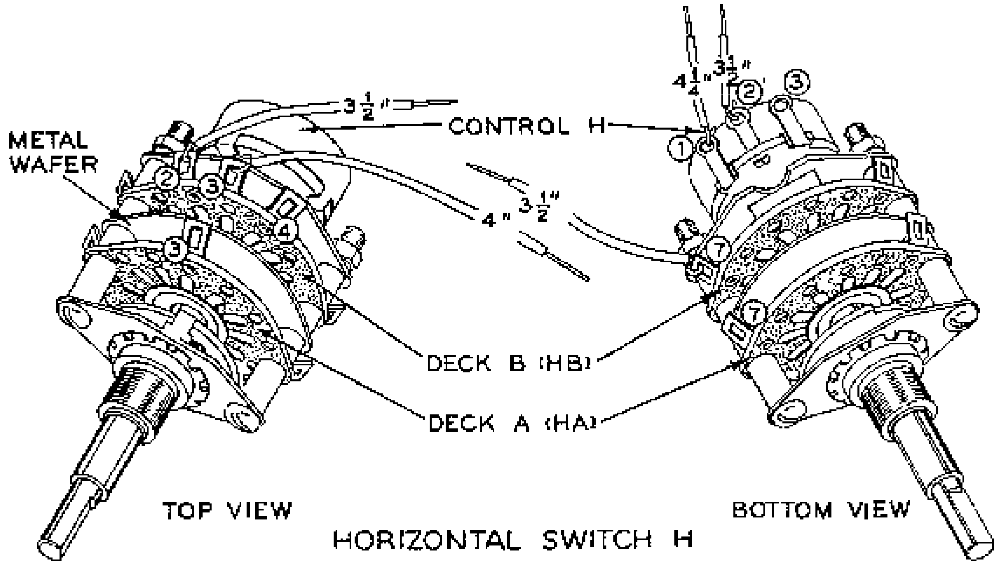


Figure 5

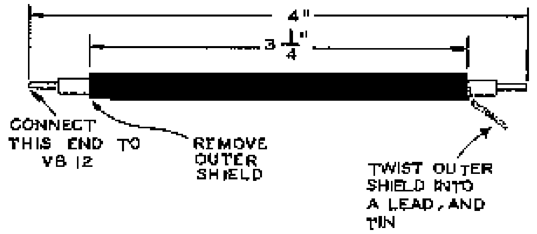
PRE-WIRING HORIZONTAL SWITCH H

Refer to Figure 5 for the following steps.

Select the remaining switch (#63-201).

CONNECT A	FROM LUG	TO
Black (✓) 3-1/2" wire	HB2 (S-1)	not connected
[illegible] (✓) 4" wire	HB3 (S-1)	not connected

CONNECT A	FROM LUG	TO
White (✓) 3-1/2" wire	HB7 (S-1)	not connected
Blue (✓) 3-1/4" wire	lug 2 of (S-1) control H	not connected
Orange (✓) 4-1/4" wire	lug 1 of (S-1) control H	not connected


4"
$3\frac{1}{4}$"
CONNECT THIS END TO VB 12
REMOVE OUTER SHIELD
TWIST OUTER SHIELD INTO A LEAD, AND TIN

Detail 4A

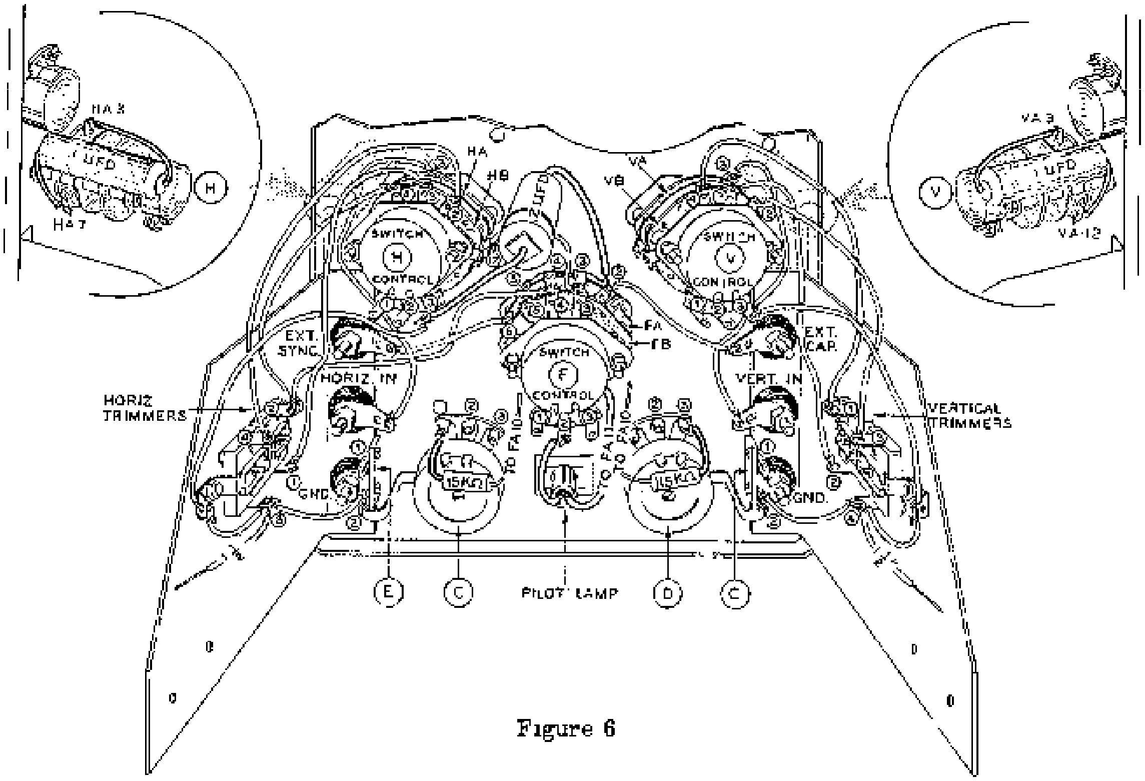


Figure 6

Refer to Figure 6 for the following steps.

(✓) Mount FREQUENCY switch F (#63-200) on the front panel using a control lockwasher, control flat washer and a control nut. Orient the switch as shown in Figure 6.

(✓) Cut off the excess length from the free lead of the 15 KΩ resistor coming from lug 3 of control D. Now connect this lead to switch lug FA10 (NS).

(✓) Connect the free lead of the 15 KΩ resistor coming from lug 1 of control C to switch lug FA10 (S-4).

(✓) Cut one of the pilot lamp leads to 1" and place 3/4" of sleeving over it. Now connect this lead to switch lug FA11 (S-3).

(✓) Cut the other pilot lamp lead to 1-3/4" and place 1-1/2" of sleeving over it. Now connect this lead to lug 2 of control F (NS).

(✓) Connect the free end of the wire coming from switch lug FB6 to the EXT.SYNC.solder lug (S-1).

(✓) Connect the free end of the wire coming from switch lug FA2 to the EXT. CAP. solder lug (S-1).

(✓) Connect the free end of the wire coming from switch lug FB4 to lug 2 of the horizontal trimmer (S-3).

(✓) Mount horizontal switch H on the front panel with a control lockwasher, control flat washer and a control nut.

(✓) C-13. Connect a .1 μfd 600 V capacitor from switch lug HA3 (NS) to HA7 (S-1). Orient as shown and use sleeving on each lead.

(✓) Connect the free end of the wire coming from the HORIZ. IN. solder lug to switch lug HA3 (S-2).

(✓) Connect the free end of the wire coming from lug 2 of the horizontal trimmer to switch lug HB4 (S-1).

(✓) Connect the free end of the wire coming from switch lug HB2 to lug 4 of the horizontal trimmer (S-5).

(✓) Connect the free end of the wire coming from switch lug HB3 to lug 1 of the horizontal trimmer (S-4).

(✓) Connect the free end of the wire coming from switch lug FB3 to switch lug HA12 (S-1).

(✓) Cut the lead at the unbanded end of the .2 μfd 200 V capacitor to 1-3/4" and place 1-1/2" of sleeving over it. Connect this lead to switch lug FA2 (S-3).

(✓) Cut the other lead of this .2 μfd capacitor to 1-1/2". Place 1-1/4" of sleeving over the lead and connect it to lug 3 of control H (NS).

(✓) Install vertical switch V on the front panel with a control lockwasher, control flat washer and control nut.

(✓) Connect the free end of the wire coming from lug 1 of the vertical trimmer to switch lug VB4 (S-2).

(✓) Connect the free end of the wire coming from the VERT. IN. solder lug to switch lug VA3 (NS).

(✓) C1. Connect a .1 μfd 600 V capacitor from switch lug VA3 (S-2) to VA12 (S-1). Orient as shown and use sleeving on each lead.

(✓) Connect the free end of the wire coming from switch lug VB3 to lug 2 of the vertical trimmer (S-4).

(✓) Connect the free end of the wire coming from switch lug VB2 to lug 3 of the vertical trimmer (S-5).

(✓) Connect a wire from lug 4 of the vertical trimmer (NS) to GND. lug G2. Solder this connection and solder the control solder lug (from under control D) to lug 2 at the same time.

(✓) Connect a wire from lug 4 of the vertical trimmer (NS) to the solder lug under the trimmer mounting screw near lug 4 (NS).

(✓) Connect a wire from this same solder lug (S-2) to lug 3 of control V (S-1).

(✓) Connect a 1-1/2" wire to lug 4 of the vertical trimmer (S-5). Do not connect the other end.

(✓) Connect a wire from lug 3 of the horizontal trimmer (NS) to GND. lug E2. Solder this connection and solder the control solder lug (from under control C) to lug 2 at the same time.

(✓) Connect a wire from lug 3 of the horizontal trimmer (NS) to the solder lug under the trimmer mounting screw near lug 3 (NS).

(✓) Connect a wire from this same solder lug (S-2) to lug 3 of control H (S-2).

(✓) Connect a 1-1/2" wire to lug 3 of the horizontal trimmer (S-5). Do not connect the other end.

(✓) Place a small black knob on each of the following controls and tighten the setscrews: VERT. CEN., HOR. CEN., FOCUS, and INTENSITY.

(✓) Install a large black knob on the outside shaft of the VERTICAL switch, HORIZONTAL switch and FREQUENCY switch. Now tighten each setscrew so that it rests against the flat spot on its shaft. Do not overtighten.

(✓) Install a small red knob on the inside shaft of each of these same three switches and tighten the setscrews.

(✓) Install red binding post caps on the VERT. and HOR. binding posts.

(✓) Install black binding post caps on the remaining binding posts.

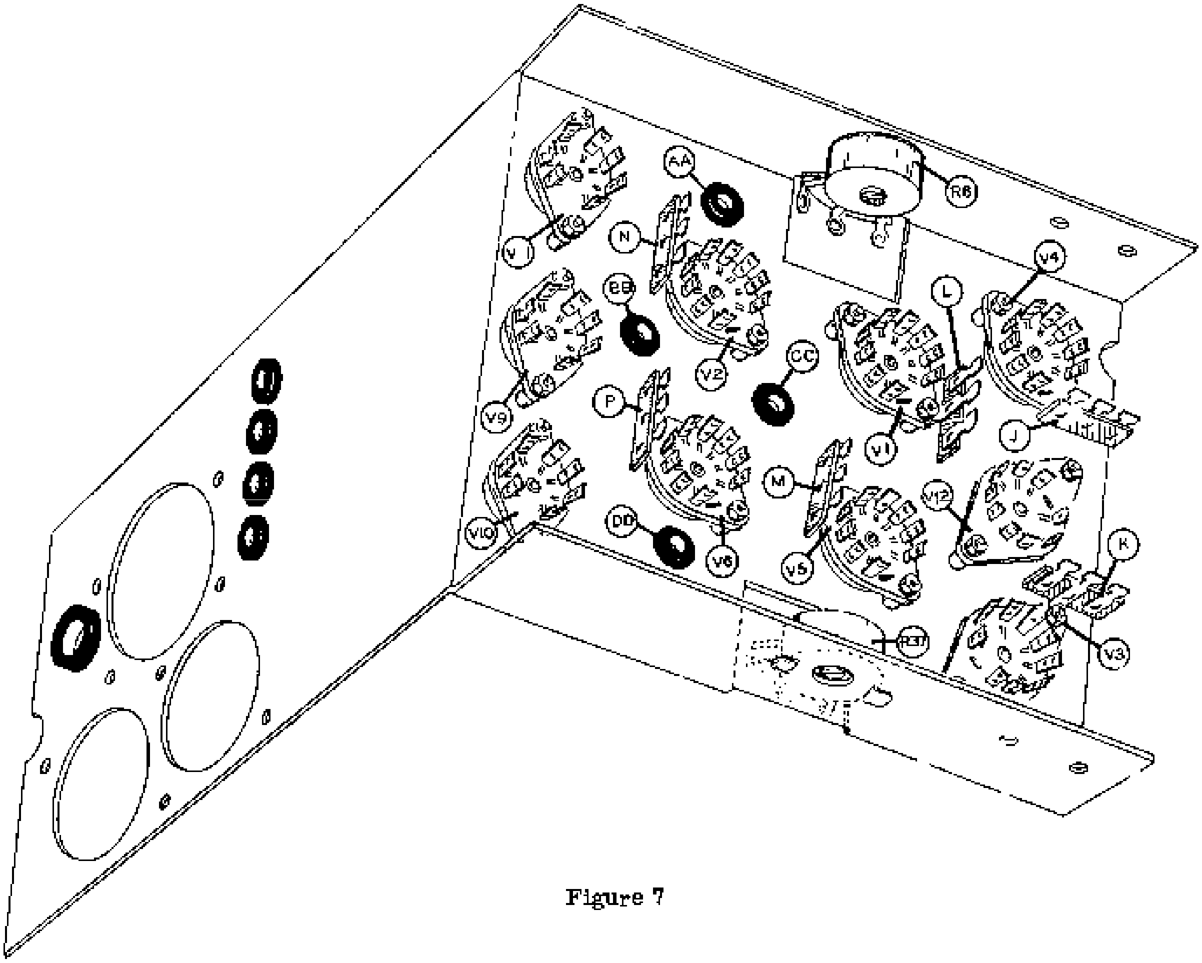


Figure 7

CHASSIS PARTS MOUNTING

Refer to Figure 7 for the following steps.

(✓) Locate the chassis, orient as shown, and install the four 5/16" rubber grommets AA, BB, CC and DD. See Figure 7.

(✓) Install the remaining four 5/16" rubber grommets in the four holes in the upper chassis apron.

NOTE: Be sure that the blank spaces in all tube sockets face in the directions shown in Figure 7.

(✓) Mount 7-pin tube sockets V9, V10, and V11. Use 3-48 x 1/2" screws, #3 x 7/32" spacers, #3 lockwashers and 3-48 nuts as shown in Detail 7A. Terminal strips are not used on these sockets. (This same hardware line-up will be used to mount all ten of the chassis tube sockets.)

(✓) Mount 9-pin tube sockets V2 and V6 and the small 3-lug terminal strips N and P. Use two #3 lockwashers with each terminal strip as shown in Detail 7A.

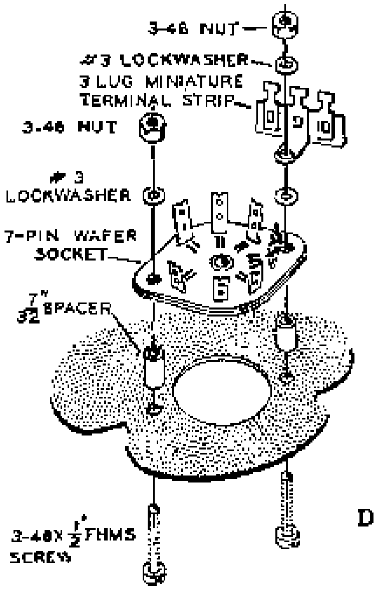
(✓) Mount 9-pin tube sockets V1 and V5, along with the small 3-lug terminal strips L and M.

(✓) Mount 9-pin tube sockets V3 and V4, along with small terminal strips J and K.

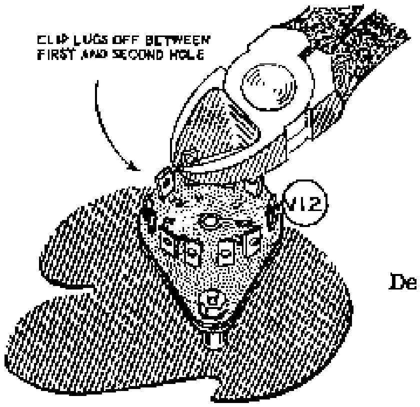
(✓) Cut off the end of each lug of a 9-pin tube socket as shown in Detail 7B. Now mount this socket, V12, as shown in Figure 7.

(✓) R6. Mount a 10 KΩ linear tab mounting control (#10-57) at R6 with the lugs facing through the top of the chassis. See Detail 7C.

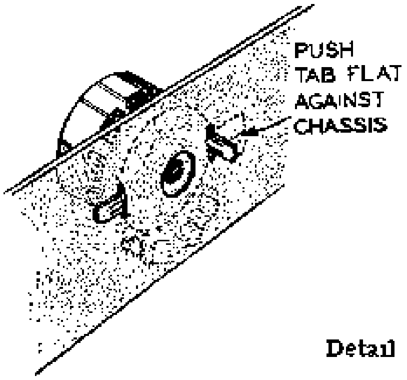
(✓) R37. Mount the other 10 KΩ linear tab mounting control (#10-57) at R37 in the same manner.



Detail 7A



Detail 7B



Detail 7C

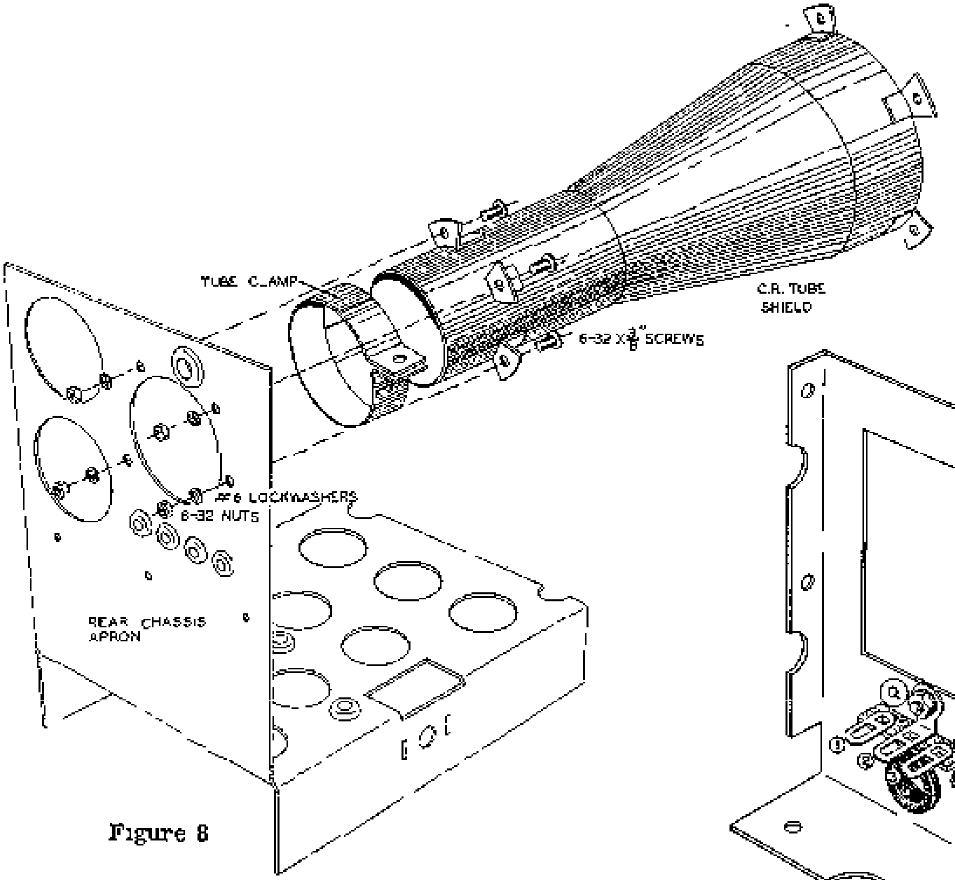


Figure 8

Refer to Figure 8 for the next step.

(✓) Install the CR tube shield on the rear chassis apron with 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts as shown. Insert the tube clamp portion through the large hole in the apron. Do not completely tighten the screws yet.

REAR SUPPORT BRACKET PARTS MOUNTING

Refer to Figure 9 for the following steps.

(✓) Mount a 1/2" rubber grommet in the hole below the position where terminal strip Q will be mounted.

(✓) Mount 3-lug terminal strip Q using a 6-32 x 3/8" screw, #6 lockwashers and a 6-32 nut. Use a lockwasher both above and below the terminal strip mounting foot. See Detail 9A.

( ) Mount 7-lug terminal strip R with 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts.

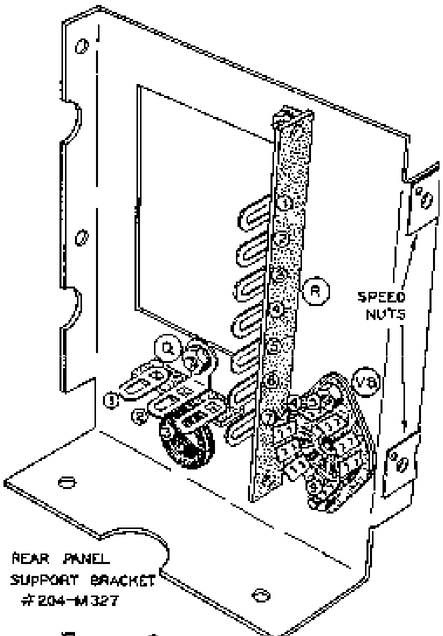
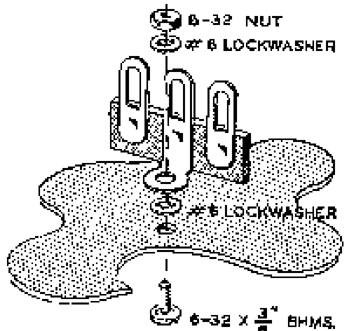


Figure 9



Detail 9A

(✓) Mount tube socket V8 with 3-48 x 5/16" screws, #3 lockwashers and 3-48 nuts.

(✓) Mount two speednuts on the rear chassis flange.

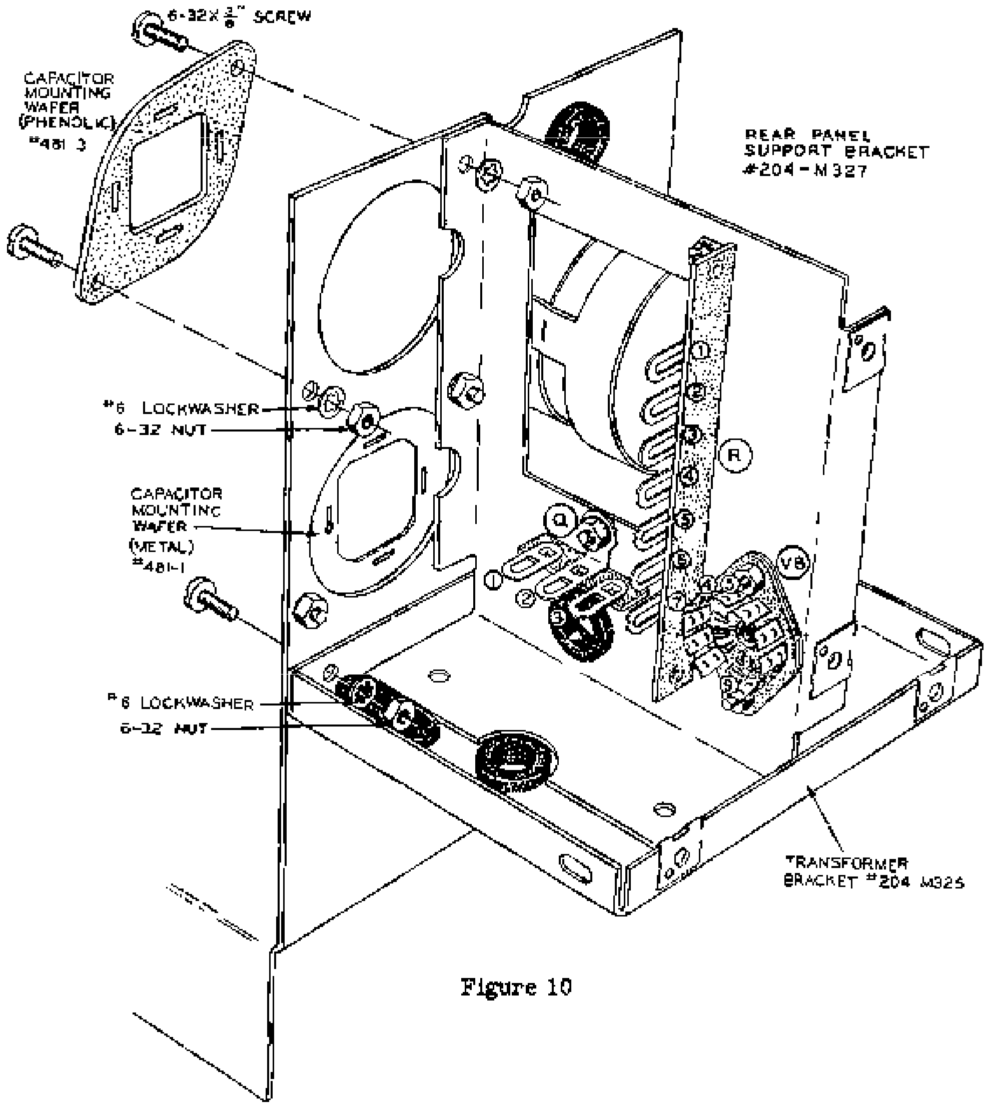

6-32 X 3/8" SCREW
CAPACITOR MOUNTING WAFER (PHENOLIC) #481-3
REAR PANEL SUPPORT BRACKET #204-M327
#6 LOCKWASHER
6-32 NUT
CAPACITOR MOUNTING WAFER (METAL) #481-1
R
Q
V8
1
2
3
4
5
6
7
#6 LOCKWASHER
6-32 NUT
TRANSFORMER BRACKET #204-M325

Figure 10

REAR SUPPORT BRACKET AND TRANSFORMER BRACKET MOUNTING

Refer to Figure 10 for the following steps.

( ) Place 1/2" grommets in the two large round holes in the transformer bracket.

( ) Place the 3/4" grommet in the large oval hole in the transformer bracket.

( ) Mount two speednuts on the rear flange of the transformer bracket.

( ) Mount the transformer bracket on the rear chassis apron. Use three 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts.

( ) **Mount the rear panel support bracket.** Note that the two mounting screws also fasten the capacitor mounting wafers. Fasten the two capacitor mounting wafers in position at the same time the rear support bracket is mounted.

( ) Install the remaining 1/2" grommet in its mounting hole in the chassis apron above the CR tube shield.

Refer to Figure 11 for the next step.

( ) Fasten the front panel assembly to the chassis assembly as shown in Figure 11. Use four 6-32 x 3/8" screws, two on each side. Insert them through the panel support brackets and through the sides of the chassis. Secure with #6 lockwashers and nuts.

Do not fasten the CR tube shield to the front panel until the CR tube is installed.

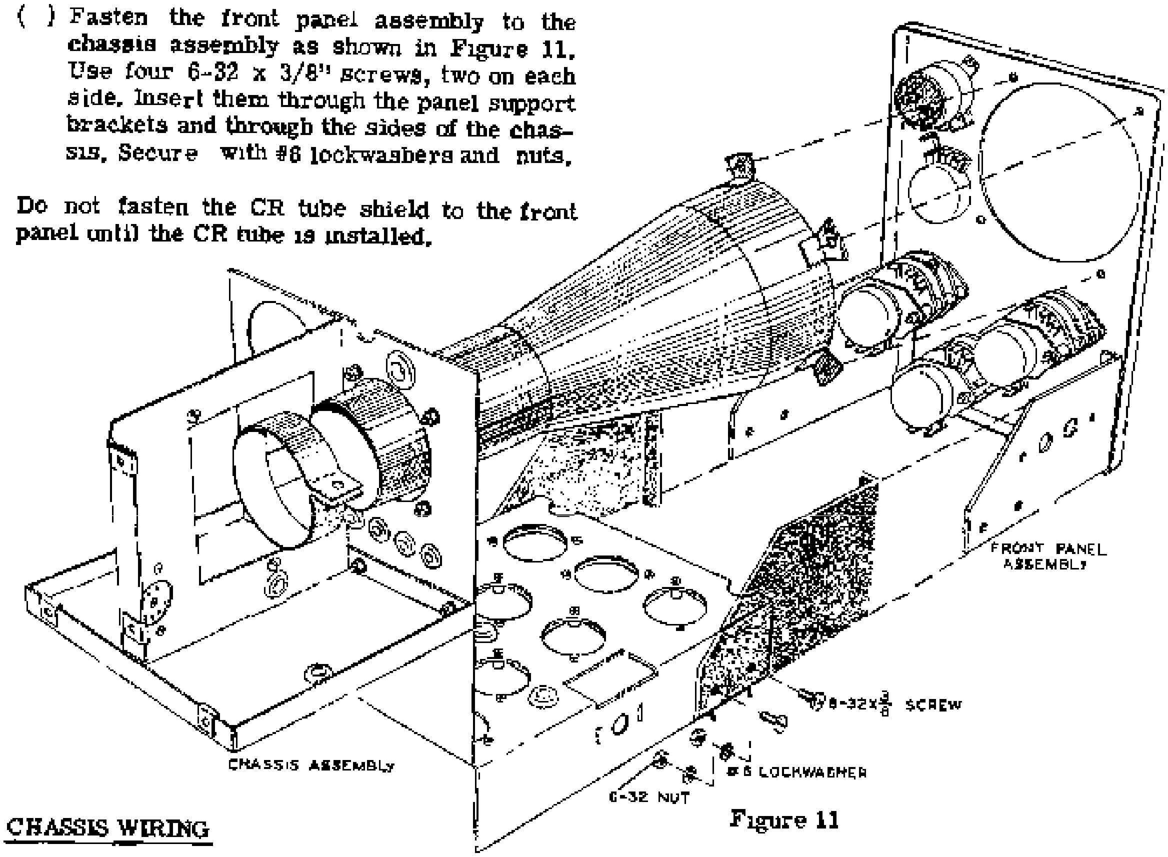


Figure 11

CHASSIS WIRING

Refer to Figure 12 (fold-out from Page 23) for the following steps.

Connect each of the following wires coming from the front panel to its connection point on the chassis. Route the wires close to the chassis as shown.

CONNECT THE WIRE COMING FROM	TO THE LOWER HOLE IN
(✓) HB7	lug 1 of terminal strip K (NS)
(✓) Lug 2 of control C	lug 2 of V5 (NS)
(✓) Lug 1 of terminal strip E	lug 1 of V3 (NS)
*( ) Lug 3 of horz. trimmer	lug 2 of terminal strip K (NS)
(✓) FA10 (the long wire)	lug 1 of terminal strip L (NS)
(✓) FA11 (the long wire)	lug 8 of V3 (S-1)
(✓) FB2	lug 1 of terminal strip N (NS)

( ) Connect the center conductor of the shielded cable coming from VB12 to lug 1 of terminal strip J (NS).

(✓) Connect the outer conductor (shield) of the shielded cable to lug 2 of terminal strip J (NS).

CONNECT THE WIRE COMING FROM	TO THE LOWER HOLE IN
(✓) Lug 2 of control D	lug 2 of V1 (NS)
(✓) Lug 2 of control V	lug 7 of V1 (S-1)
(✓) Lug 1 of control V	lug 2 of control R6 (NS)
*(✓) Lug 4 of vert. trimmer.	through lug 2 of terminal strip J (NS) to lug 9 of V12 (S-1)
(✓) Lug 2 of control H	lug 7 of V5 (S-1)
(✓) Lug 1 of control H	lug 2 of control R37 (NS)

*These connections are shown in Figure 12A.

( ) Connect the wire from switch lug FA8 to lug 7 of V3 (NS).

The wire from FB5 and the two short wires from FA11 and FA10 will not be connected until later.

FILAMENT WIRING

Refer to Figure 12 (fold-out from Page 23) for the following steps.

Connect a hookup wire between each of the following terminals. Route each wire as shown in Figure 12.

CONNECT A WIRE FROM THE LOWER HOLE IN	TO THE LOWER HOLE IN
(✓) Lug 9 of V2 (NS)	lug 9 of V6 (NS)
(✓) Lug 9 of V6 (NS)	lug 3 of V10 (S-1)
(✓) Lug 9 of V6 (S-3)	lug 5 of V5 (NS)
(✓) Lug 5 of V5 (S-2)	through lug 4 (NS) to lug 5 (S-1) of V3, now solder lug 4 (S-2)
(✓) Lug 9 of V2 (NS)	lug 5 of V1 (NS)
(✓) Lug 5 of V1 (S-2)	lug 9 of V4 (NS)
(✓) Lug 9 of V4 (S-2)	lug 5 of V12 (S-1)
(✓) Lug 4 of V12 (NS)	through lug 4 (NS) to lug 5 (S-1) of V4
(✓) Lug 4 of V4 (S-3)	lug 4 of V1 (NS)
(✓) Lug 4 of V1 (S-2)	through lug 5 (NS) to lug 4 of V2 (NS)
(✓) Lug 4 of V10 (S-1)	through lug 4 (NS) to lug 5 (NS) of V6, now solder lug 4 (S-2)
(✓) Lug 5 of V6 (S-2)	lug 4 of V2 (S-2)
(✓) Lug 9 of V3 (NS)	lug 4 of V5 (S-1)
( ) Lug 9 of V3 (S-2)	lug 4 of V12 (S-2)

GROUND BUS WIRING

Refer to Figure 12A for the following steps.

CONNECT A WIRE FROM	TO THE LOWER HOLE IN
2½ (✓) Lug 2 of terminal strip J (NS)	lug 2 of terminal strip L (NS)
(✓) Lug 2 of terminal strip K (NS)	through lug 2 of terminal strip L (NS) to lug 9 of V1 (S-1)
(✓) Lug 9 of V5 (S-1)	lug 2 of terminal strip K (NS)
2½ (✓) Lug 2 of terminal strip L (NS)	lug 2 of terminal strip M (NS)
(✓) Lug 2 of terminal strip M (NS)	lug 2 of terminal strip P (NS)
2½ (✓) Lug 2 of terminal strip P (NS)	lug 2 of terminal strip N (NS)
(✓) Lug 7 of V9 (S-1)	lug 2 of terminal strip P (NS)

POINT TO POINT CHASSIS WIRING

Refer to Figure 12A for the following steps.

CONNECT A WIRE FROM	TO
(✓) Lug 3 of terminal strip P (NS)	lug 3 of terminal strip N (NS)
(✓) Lug 3 of terminal strip P (NS)	lug 6 of V3 (S-1)
(✓) Lug 1 of terminal strip P (NS)	through lug 3 of terminal strip L (NS) to lug 6 of V12 (S-1)
(✓) Lug 3 of terminal strip L (NS)	lug 1 of V12 (NS)
(✓) Lug 1 of V12 (S-2)	lug 3 of terminal strip J (NS)
(✓) Lug 3 of terminal strip L (NS)	lug 1 of V3 (NS)
(✓) Lug 3 of V3 (NS)	lug 3 of V4 (S-1)
(✓) Lug 7 of V3 (S-2)	lug 8 of V4 (S-1)
(✓) Lug 3 of V12 (S-1)	lug 3 of R37 (NS)
2½ (✓) Lug 8 of V12 (S-1)	lug 3 of R6 (NS)

Use the bottom holes only when making the following connections to terminal strip M.

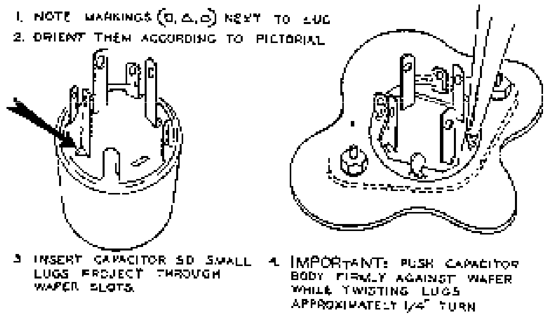
CONNECT A WIRE FROM	TO
(✓) Lug 4 of V11 (S-1)	lug 1 of terminal strip M (NS)
(✓) Lug 1 of terminal strip M (NS)	lug 3 of terminal strip M (NS)
(✓) Lug 1 of terminal strip M (NS)	lug 1 of terminal strip L (NS)

FILTER CAPACITOR MOUNTING

Refer to Figure 13 for the following steps.

( ) Mount capacitor S (#25-109) by inserting the four outside lugs through the slots of the metal capacitor mounting wafer. See Detail 13A. Fasten the capacitor by twisting each of the four outside lugs approximately 1/4 turn.

( ) Mount capacitor T (#25-108) on the phenolic wafer in the same manner.


1. NOTE MARKINGS (□, △, ○) NEXT TO LUG
2. ORIENT THEM ACCORDING TO PICTORIAL
3. INSERT CAPACITOR SO SMALL LUGS PROJECT THROUGH WAFER SLOTS.
4. IMPORTANT: PUSH CAPACITOR BODY FIRMLY AGAINST WAFER WHILE TWISTING LUGS APPROXIMATELY 1/4" TURN

Detail 13A

CHASSIS TO POWER SUPPLY WIRING

Refer to Figures 12A and 13 for the following steps.

Each of the following wires is first connected to a lug on the chassis (use the lower hole of each lug), then it is routed around the rear corner of the chassis near V10 and up through grommet EE to a lug in the power supply section. For each of these steps, refer first to Figure 12A for the chassis connection, then to Figure 13 for the power supply connection.

(✓) Connect a wire from lug 2 of terminal strip P (NS) to lug 5 of capacitor S (NS).

(✓) Connect a wire from lug 7 of V10 (S-1) to lug 2 of capacitor S (NS).

(✓) Connect a wire from lug 5 of V9 (S-1) to lug 7 of terminal strip R (NS).

(✓) Connect a wire from lug 1 of terminal strip P (NS) to lug 1 of capacitor S (S-1).

( ) Connect a wire from lug 3 of terminal strip P (NS) to lug 3 of capacitor S (NS).

(✓) Connect a wire from lug 5 of V11 (S-1) to lug 2 of terminal strip R (NS).

( ) Connect a wire from lug 3 of terminal strip M (NS) to lug 4 of capacitor T (NS).

(✓) Strip each end of an 18" length of high voltage insulated wire. Connect one end of this wire to lug 7 of V4 (NS).

(✓) Route this wire across the chassis as shown in Figure 12 and up through grommet EE to the power supply section. Insert the rest of the lead through grommet FF, below terminal strip Q and leave it disconnected until later.

DEFLECTION PLATE LEADS

(✓) Strip each end of an 8" high voltage insulated wire. Connect this wire to lug 8 of V2 (NS). Route the other end up through grommet AA to be connected later. See Figure 12A.

(✓) Strip each end of an 8" high voltage insulated wire. Connect this wire to lug 1 of V2 (NS). Route the other end of the wire up through grommet BB to be connected later.

(✓) Strip each end of a 9" length of high voltage insulated wire. Connect this wire to lug 8 of V8 (NS). Route the other end of the wire up through grommet CC to be connected later.

(✓) Strip each end of a 9" high voltage insulated wire. Connect this wire to lug 1 of V8 (NS). Route the other end of the wire up through grommet DD to be connected later.

POWER SUPPLY WIRING

Refer to Figure 13 for the following steps.

( ) Connect a wire from lug 3 of capacitor S (NS) to lug 5 of terminal strip R (NS). See Figure 13.

( ) Connect a wire from lug 4 of capacitor S (NS) to lug 6 of terminal strip R (NS).

(✓) Connect a wire from lug 2 of capacitor T (NS) to lug 1 of terminal strip R (NS).

( ) Connect a wire from lug 1 of capacitor T (NS) to lug 3 of terminal strip R (NS).

( ) Connect a wire from lug 3 of capacitor T (S-1) to the closest mounting lug of capacitor S (S-1).

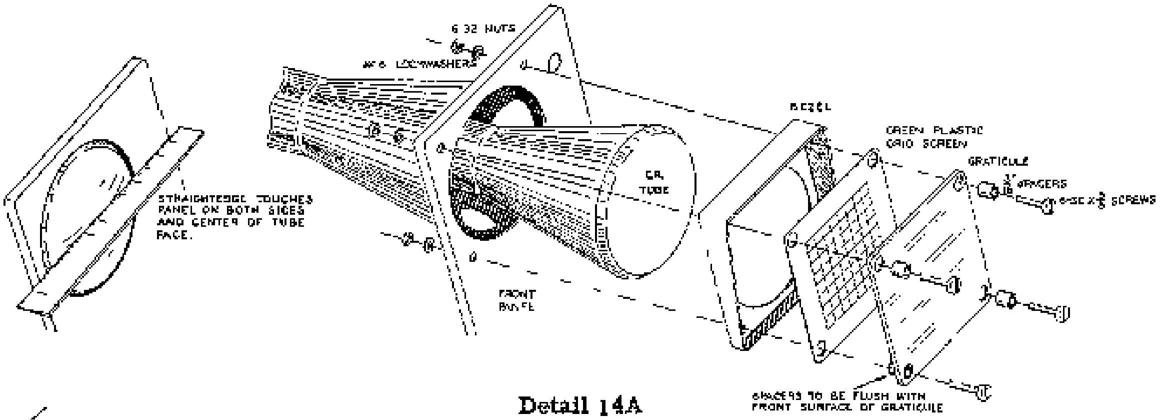
( ) Connect a wire from lug 5 of capacitor S (NS) to lug 2 of terminal strip Q (NS).

( ) Strip each end of a 4-1/4" wire. Connect one end of the wire to lug 2 of terminal strip Q (NS). Insert the other end of the wire through grommet FF. Leave this end free.

( ) Strip each end of a 7" wire and connect one end to lug 2 of terminal strip Q (S-3). The other end of the wire will be connected later.

( ) Strip each end of a 3" wire and connect one end to lug 5 of terminal strip R (NS). Leave the other end free.

( ) Connect a length of high voltage insulated wire between lug 3 of terminal strip Q (NS) and lug 9 of tube socket V8 (S-1).


6 32 NUTS
#6 LOCKWASHERS
STRAIGHTEDGE TOUCHES PANEL ON BOTH SIDES AND CENTER OF TUBE FACE.
CR TUBE
FRONT PANEL
BEZEL
GREEN PLASTIC GRID SCREEN
GRATICULE
$\frac{1}{16}$" SPACERS
6-32 x $\frac{5}{8}$ SCREWS
SPACERS TO BE FLUSH WITH FRONT SURFACE OF GRATICULE

Detail 14A

(✓) Strip each end of a 9" high voltage insulated wire. Connect one end of this wire to lug 1 of terminal strip Q (NS) and route the other end through grommet FF.

(✓) C20. Cut the lead at the unbanded end of a .1 µfd 1200 V DC capacitor to 2" and place 1-1/2" of sleeving over it. Insert this lead through grommet FF from the other side of the bracket and connect it to lug 1 of terminal strip Q (NS). The body of the capacitor should be toward the front as it appears in Figure 14. Do not fasten the other lead.

(✓) C21. Place 1-3/4" of sleeving over the lead from the unbanded end of the remaining .1 µfd 1200 V DC capacitor. Insert this lead through grommet FF from the other side of the bracket and connect it to lug 3 of terminal strip Q (NS). Place the body of the capacitor as it appears in Figure 14. Do not connect the other lead.

(✓) R58. Connect a 1 megohm (brown-black-green) resistor between lug 1 (S-3) and lug 3 (S-3) of terminal strip Q.

(✓) Connect the silicon rectifier between lug 3 (S-2) and lug 4 (NS) of terminal strip R. Make sure that the red (+) end is connected to lug 3.

(✓) Mount the power transformer on the transformer bracket with 8-32 x 3/8" screws, #8 lockwashers and 8-32 nuts. Insert the blue, yellow and red-yellow leads up through the grommet into the power supply section. Insert the brown, black and green-yellow leads up through the 1/2" grommet on the other side of the transformer bracket.

INSTALLING THE CR TUBE

Refer to Figure 14A and 14B for the following steps.

(✓) Trim and install the cushion strip on the inside of the clamp at the rear of the CR tube shield as shown in Detail 14B.

CAUTION: Carefully open the carton containing the 3RP1 cathode ray tube. Handle the tube with reasonable caution, since it has been highly evacuated. Should the envelope be broken, the resulting implosion could spray the area with shattered glass with possibly serious consequences. Avoid handling the tube while wearing diamond rings which might scratch the glass. Do not strike the envelope with tools and do not subject it to impact or shock.

(✓) Slide the CR tube into the CR tube shield from the front panel. As the base of the tube emerges from the clamp, install the CR tube socket. Align the front of the tube with the panel, using a straight edge as shown. Pin 1 of the CR tube socket should be toward the top of the panel.

( ) Install a 6-32 x 5/8" screw in the tube base clamp and secure with a #6 lockwasher and 6-32 nut. DO NOT overtighten.

( ) Using 6-32 x 5/8" screws, install the bezel, green grid screen and graticule on the front panel as shown in Detail 14A. Fasten the CR tube shield to the front panel with these same 6-32 x 5/8" screws. Now go back and tighten the four screws that mount the CR tube shield to the rear chassis apron.

WIRING THE CR TUBE SOCKET

Refer to Figure 14 for the following steps.

(✓) Install #6 solder lug W with a 6-32 x 3/8" screw and a 6-32 nut.

(✓) Connect the wire coming through grommet FF (from lug 2 of terminal strip Q) to solder lug W (NS).

(✓) Connect the free lead of capacitor C20 (.1 µfd 1200 V) to solder lug W (NS). Route the long wire coming from grommet FF behind C20 before fastening the capacitor lead.

(✓) Cut the green-yellow transformer lead to length and strip 1/4" of insulation from the end. Connect this lead to solder lug W (NS).

(✓) Connect the free lead of capacitor C21 (.1 µfd 1200 V) to solder lug W (S-4).

NOTE: All of the wires connected to the CR tube socket (except resistor, capacitor, or transformer leads) will be high voltage insulated wire.

(✓) Strip each end of a 5" high voltage insulated wire. Connect one end to lug 8 of the CR tube socket (S-1). Leave the other end disconnected and routed through the large opening into the power supply section.

(✓) Insert the wire coming from chassis grommet DD through 5/16" grommet #1. Connect this wire to lug 9 of the CR tube socket (S-1).

(✓) Insert the wire coming from chassis grommet CC through 5/16" grommet #2. Connect this wire to lug 10 of the CR tube socket (S-1).

( ) Insert the wire coming from chassis grommet BB through 5/16" grommet #3. Connect this wire to lug 7 of the CR tube socket (S-1).

(✓) Insert the wire coming from chassis grommet AA through 5/16" grommet #4. Connect this wire to lug 6 of the CR tube socket (S-1).

(✓) Connect the shorter wire coming from grommet FF to lug 5 of the CR tube socket (NS).

(✓) R52. Connect a 100 KΩ (brown-black-yellow) resistor from lug 1 (NS) to lug 2 (S-1) of the CR tube socket.

(✓) Connect the longer wire coming from grommet FF to lug 1 of the CR tube socket (NS).

(✓) C19. Connect a .01 µfd 1600 V capacitor from lug 3 (NS) to lug 5 (S-2) of the CR tube socket.

(✓) R53. Connect a 1 megohm (brown-black-green) resistor from lug 11 (NS) to lug 3 (S-2) of the CR tube socket.

(✓) Strip each end of an 11" high voltage insulated wire. Connect one end of this wire to lug 3 of control A on the front panel (S-1).

(✓) Route the other end of this wire through grommet GG and connect it to lug 11 of the CR tube socket (S-2).

( ) Strip each end of an 11-1/2" high voltage insulated wire. Connect one end of this wire to lug 2 of control B on the front panel (S-1).

( ) Route the other end of this wire through grommet GG to lug 4 of the CR tube socket (S-1).

( ) Strip each end of an 11" high voltage insulated wire. Connect one end of this wire to lug 1 of control A (S-1).

( ) Route the other end of this wire through grommet GG to lug 1 of the CR tube socket (NS).

17 ,- + —

( ) Twist two 20" lengths of hookup wire together tightly and cut the pair to a length of 18". Connect each wire at one end of this pair to a switch lug on the rear of control A. Solder each of these connections.

( ) Route this twisted pstr through grommet GG and down across the bottom of the transformer bracket to the rear as shown in Figure 14. The other end of this twisted pair will be connected later.

( ) Cut 2" from the brown transformer leads and twist them together loosely. Connect one lead to lug 12 of the CR tube (S-1).

( ) Connect the other brown transformer lead to lug 1 of the CR tube (S-4).

All twelve lugs of the CR tube socket should now have been soldered.

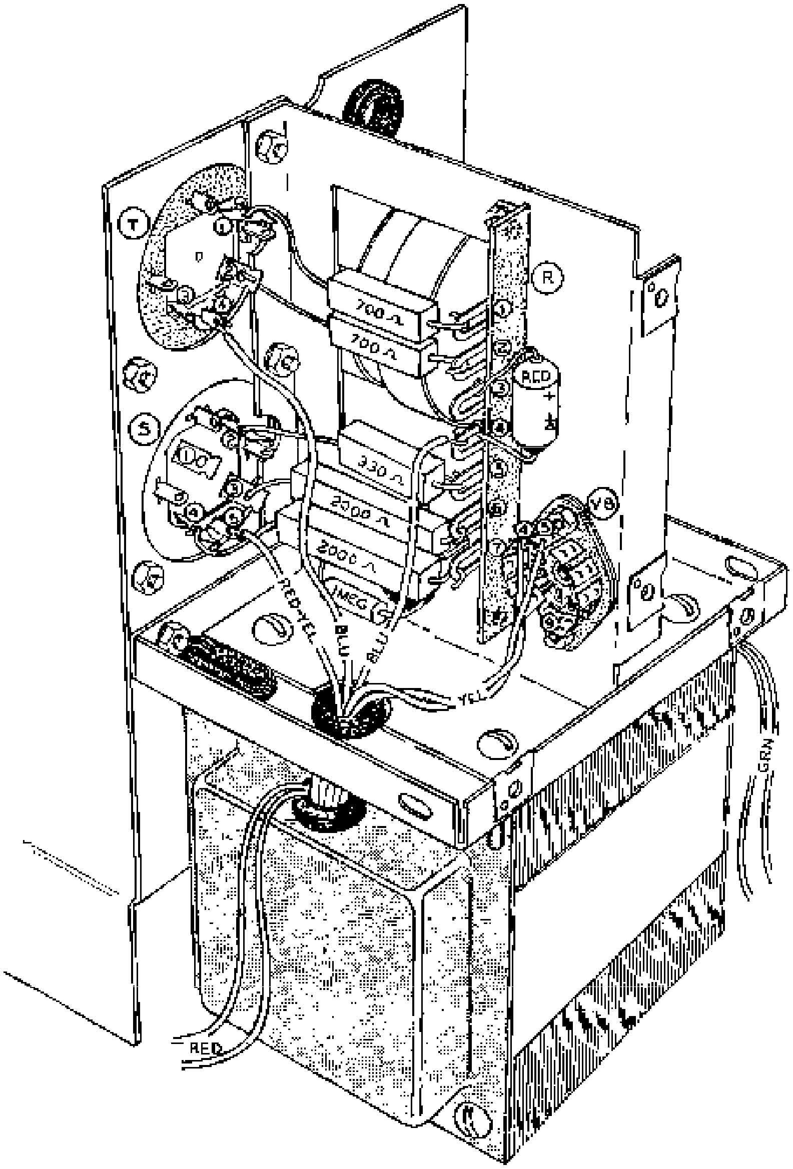


Figure 15

POWER SUPPLY CONNECTIONS

See Figure 15 for the following steps.

( ) Cut the red-yellow transformer lead to length and connect it to lug 5 of capacitor S (S-3).

(✓) Twist the two yellow transformer leads together loosely, cut off the excess lead lengths and connect one lead to lug 4 of tube socket V8 (S-1).

(✓) Connect the other yellow transformer lead to lug 6 of tube socket V8 (S-1).

(✓) Cut off the excess lead and connect a blue transformer lead to lug 4 of terminal strip R (S-2).

(✓) Cut off the excess lead and connect the other blue transformer lead to lug 4 of capacitor T (S-2).

(✓) R61. Connect a 2000 Ω 10 watt resistor from lug 6 of terminal strip R (S-2) to lug 3 of capacitor S (S-3).

( ) R60. Connect a 2000 Ω 10 watt resistor from lug 7 of terminal strip R (S-2) to lug 4 of capacitor S (S-2).

(✓) R62. Connect a 330 Ω 7 watt resistor from lug 5 of terminal strip R (S-3) to lug 2 of capacitor S (S-2).

( ) R64. Connect a 700 Ω 7 watt resistor from lug 2 of terminal strip R (S-2) to lug 2 of capacitor T (S-2).

( ) R65. Connect a 700 Ω 7 watt resistor from lug 1 of terminal strip R (S-2) to lug 1 of capacitor T (S-2).

All power supply connections should now have been soldered.

FINAL CHASSIS WIRING

Refer to Figure 16 for the following steps. The photograph on the rear of the schematic may also prove helpful.

( ) Twist the two green power transformer leads together loosely and route them, as shown, to tube socket V2. Cut one of the leads to the proper length and connect it to lug 5 of V2 (S-3).

( ) Cut the other green transformer leads to length and connect it to lug 9 of tube socket V2 (S-3).

( ) Twist the two red power transformer leads together loosely and route them, as shown, to tube socket V10. Cut one lead to length and connect it to lug 1 of V10 (S-1).

( ) Cut the other red transformer lead to length and connect to lug 8 of tube socket V10 (S-1).

NOTE: Place each of the following components as they appear in Figure 16.

(✓) Connect a length of bare wire from lug 1 (S-1) to lug 7 (NS) of tube socket V4.

(✓) R24. Connect a 10 KΩ (brown-black-orange) 1/2 watt resistor from lug 7 of tube socket V4 (S-3) to lug 3 of terminal strip J (NS).

(✓) R28. Connect a 15 KΩ (brown-green-orange) 1/2 watt resistor from lug 6 of tube socket V4 (NS) to lug 3 of terminal strip J (S-3).

( ) C12. Connect a .1 μfd 200 V capacitor from lug 2 (NS) to lug 6 (S-2) of tube socket V4. Place as shown and use sleeving on the longer lead.

( ) R1. Connect a 100 Ω (brown-black-brown) resistor from lug 7 of tube socket V12 (S-1) to lug 1 of terminal strip J (S-2). Place the body of this resistor between lug 8 and the terminal strip as shown in Figure 16.

NOTE: The area below tube socket V12 is purposely being kept free of leads and components. This is because a control, R88, will be mounted at that position later.

( ) R25. Connect a 100 KΩ (brown-black-yellow) resistor from lug 2 of tube socket V4 (NS) to lug 2 of terminal strip J (S-5).

( ) R22. Place 1-1/4" of sleeving over one lead of a 1 megohm (brown-black-green) resistor. Connect this lead to lug 2 of tube socket V4 (S-3). Use sleeving and connect the other lead of this resistor to switch lug FA9 of front panel switch F (S-1).

( ) R34. Connect a 100 Ω (brown-black-brown) resistor from lug 2 of tube socket V12 (S-1) to lug 1 of terminal strip K (S-2). Place the body of the resistor as shown.

(✓) R26. Connect a 1 megohm (brown-black-green) resistor from lug 2 of tube socket V3 (NS) to lug 2 of terminal strip K (S-4).

( ) R23. Connect a 100 Ω (brown-black-brown) resistor from lug 2 of tube socket V3 (S-2) to lug 3 of terminal strip K (NS).

NOTE: Because of their relatively large size, it is recommended that you do not wrap the leads of the 1 watt and 2 watt resistors around the lugs they connect to. Merely lay the lead against a terminal lug, or through the hole of a tube socket lug and solder.

(✓) R19. Route one lead of a 10KΩ (brown-black-orange) 2 watt resistor through lug 8 (NS) to lug 3 (S-1) of tube socket V2. Now solder lug 8 (S-2). Place the resistor as shown and connect the other lead to lug 2 of terminal strip N (NS).

(✓) R20. Connect a 22 KΩ (red-red-orange) 2 watt resistor from lug 1 of tube socket V2 (S-2) to lug 3 of terminal strip N (NS). Place the resistor body as shown.

(✓) R9. Connect a 2200 Ω (red-red-red) resistor from lug 1 of terminal strip N (NS) to lug 1 of terminal strip P (NS).

( ) R49. Route one lead of a 10 KΩ (brown-black-orange) 2 watt resistor through lug 8 (NS) to lug 3 (S-1) of tube socket V6. Now solder lug 8 (S-2). Place the resistor as shown and route the other lead to lug 2 of terminal strip P (S-5).

(✓) R48. Connect a 22 KΩ (red-red-orange) 2 watt resistor from lug 3 of terminal strip P (NS) to lug 1 of tube socket V6 (S-2).

(✓) R7. Connect a 10 KΩ (brown-black-orange) 1 watt resistor from lug 1 of control R6 (S-1) to lug 1 of terminal strip M (NS).

(✓) R35. Connect a 10 KΩ (brown-black-orange) 1 watt resistor from lug 1 of control R37 (S-1) to lug 3 of terminal strip M (NS).

(✓) R17. Route one lead of a 15 KΩ (brown-green-orange) 1 watt resistor through lug 3 (NS) to lug 8 (S-1) of tube socket V1. Now solder lug 3 (S-2). Cut the other lead to length and connect it to lug 1 of terminal strip L (S-3).

(✓) R27. Cut one lead of a 6800 Ω (blue-gray-red) 2 watt resistor to a length of 1/2". Save the clipped off portion. Connect the short lead of the 6800 Ω resistor to lug 3 of tube socket V3 (S-2). Place the resistor as shown and connect the other lead to lug 1 of terminal strip M (S-5).

( ) Place the lead clipped off R27 between lug 3 (S-1) and lug 8 (NS) of tube socket V5.

( ) R46. Connect a 15 KΩ (brown-green-orange) 1 watt resistor from lug 8 of tube socket V5 (S-2) to lug 3 of terminal strip M (S-4). Place the body of the resistor as shown.

( ) R5. Connect a 1000 Ω (brown-black-red) resistor from lug 2 (S-2) to lug 3 (S-2) of control R6. This resistor will be easier to install from above the chassis.

( ) R36. Connect a 1000 Ω (brown-black-red) resistor from lug 2 (S-2) to lug 3 (S-2) of control R37. This resistor will be easier to install from above the chassis.

( ) C11. Connect the 1.0 μfd 200 volt capacitor from lug 3 of terminal strip K (S-2) to switch lug FB10 (S-1).

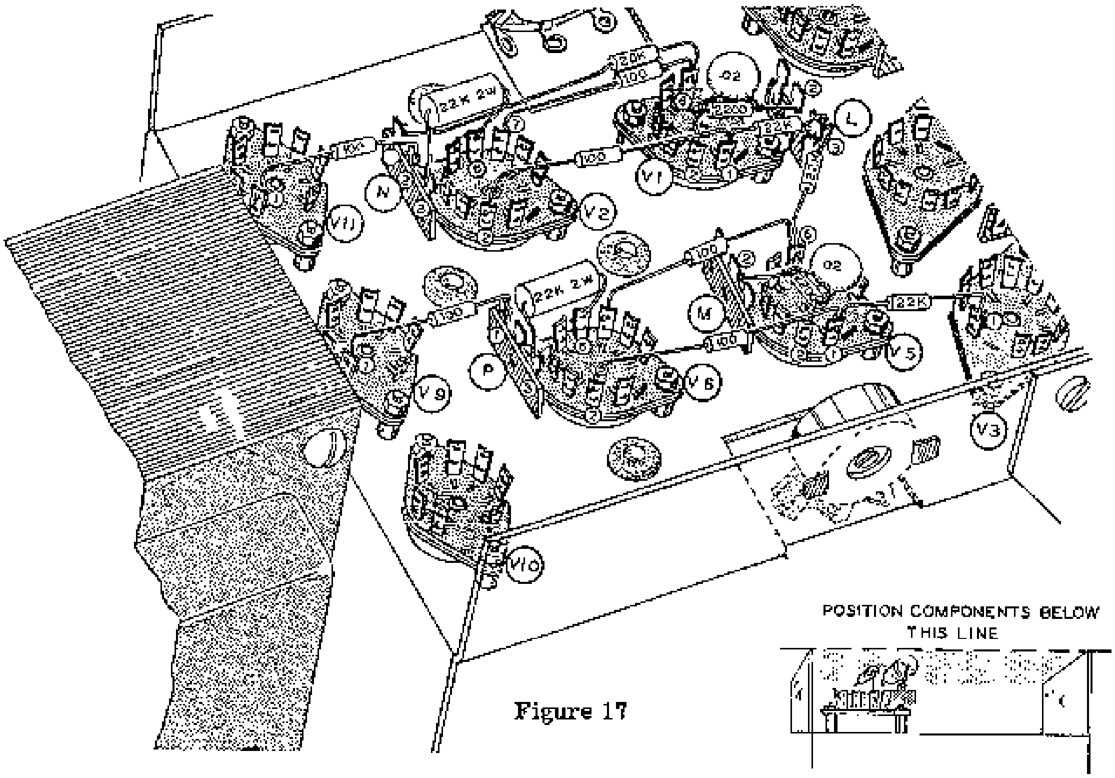


Figure 17

Detail 17A

Refer to Figure 17 for the following steps.

NOTE: All resistors in Figure 17 are wired above the tube sockets, as shown in Detail 17A. This is done for the purpose of simplifying the wiring and eliminating the need for sleeving.

( ) R63. Connect a 100 Ω (brown-black-brown) resistor from lug 1 of tube socket V11 (S-1) to lug 2 of terminal strip N (S-2). Be sure and solder the bottom hole.

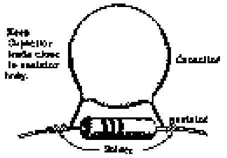
( ) R59. Connect a 100 Ω (brown-black-brown) resistor from lug 1 of tube socket V9 (S-1) to lug 1 of terminal strip P (S-4). Solder the bottom hole first.

( ) R21. Connect a 22 KΩ (red-red-orange) 2 watt resistor from lug 6 of tube socket V2 (S-2) to lug 3 of terminal strip N (S-3). Solder the bottom hole first.

(✓) R10. Connect a 20 KΩ (red-black-orange) resistor from lug 6 of tube socket V1 (NS) to lug 1 of terminal strip N (S-3). Solder the bottom hole first.

(✓) R18. Connect a 100 Ω (brown-black-brown) resistor from lug 6 of tube socket V1 (S-2) to lug 7 of tube socket V2 (S-1).

( ) Clip the leads of a .02 µfd disc capacitor to 1/2". Wrap these leads around the leads of a 2200 Ω (red-red-red) resistor as shown in Detail 17B. Now solder the leads at each end of the resistor.


Method for Connecting Resistor and Capacitor in parallel.
Keep capacitor leads close to resistor body.
Capacitor
Resistor
Solder

Detail 17B

(✓) R15 and C6. Connect this .02 μfd capacitor and 2200 Ω resistor combination from lug 2 of tube socket V1 (S-2) to lug 2 of terminal strip L (S-5). Lay the capacitor body down flat being careful that its leads do not touch any other leads or lugs.

(✓) R16. Connect a 100 Ω (brown-black-brown) resistor from lug 1 of tube socket V1 (NS) to lug 2 of tube socket V2 (S-1).

(✓) R11. Connect a 22 KΩ (red-red-orange) resistor from lug 1 of tube socket V1 (S-2) to lug 3 of terminal strip L (NS).

(✓) R50. Connect a 22 KΩ (red-red-orange) 2 watt resistor from lug 6 of tube socket V6 (S-2) to lug 3 of terminal strip P (S-5). (Solder bottom hole first in each case.)

(✓) R47. Connect a 100 Ω (brown-black-brown) resistor from lug 6 of tube socket V5 (NS) to lug 7 of tube socket V6 (S-1).

( ) R39. Connect a 22 KΩ (red-red-orange) resistor from lug 6 of tube socket V5 (S-2) to lug 3 of terminal strip L (S-6).

(✓) Clip the leads of a .02 μfd disc capacitor to 1/2". Wrap these leads around the leads of a 2200 Ω (red-red-red) resistor in the same manner as before. Solder the connections.

(✓) R44 and C18. Connect this .02 μfd capacitor and 2200 Ω resistor combination from lug 2 of tube socket V5 (S-2) to lug 2 of terminal strip M (S-3). Lay the capacitor body down flat as before.

(✓) R45. Connect a 100 Ω (brown-black-brown) resistor from lug 2 of tube socket V6 (S-1) to lug 1 of tube socket V5 (NS).

( ) R40. Connect a 22 KΩ (red-red-orange) resistor from lug 1 of tube socket V3 (S-3) to lug 1 of tube socket V5 (S-2).

This completes the construction of the chassis section of your IO-10 Oscilloscope. Since the components are rather closely spaced, it would be well to check all components and connections carefully for mistakes, shorted wires or poor solder joints. All connections on the chassis should be soldered.

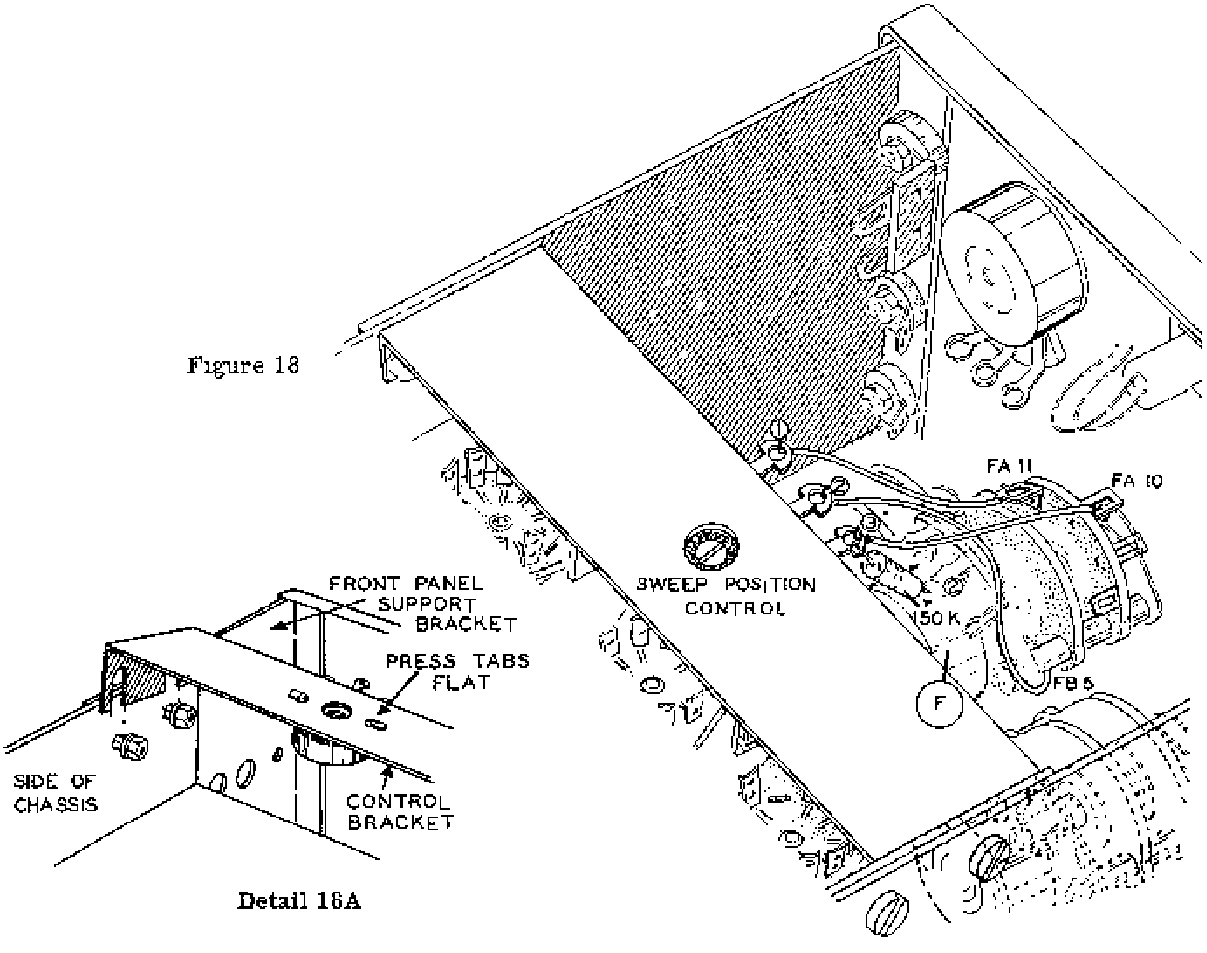


Figure 18

Detail 18A

CONTROL BRACKET WIRING

Refer to Figure 18 for the following steps.

( ) R56. Install the 100 KΩ tab-mounting sweep position control (#10-56) in the control bracket as shown in Figure 18A.

( ) Loosen the four screws that hold the front panel support brackets to the chassis. Slide the slots of the control bracket under the nuts and lockwashers as shown in Detail 18A. Adjust the control bracket flat with the bottom of the chassis, and then tighten the four screws.

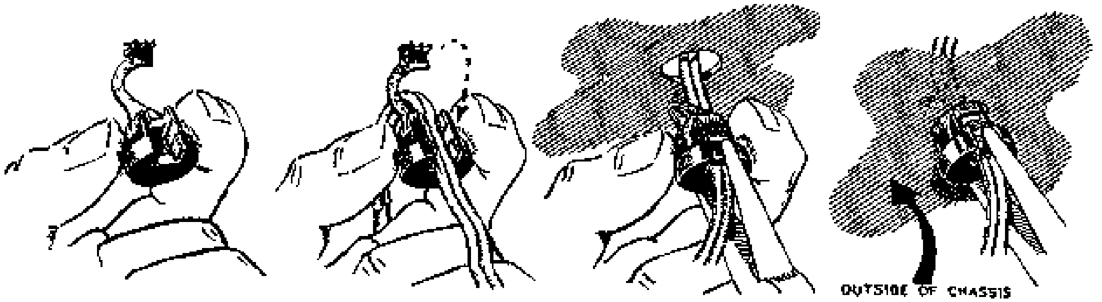
NOTE: Make sure thet no bare wires or lugs extend up to where they could be shorted out by touching the metal body of the control as it is pressed down.

( ) Connect the wire coming from switch lug FA11 to lug 1 of the Sweep Position control (S-1).

( ) Connect the wire coming from FB5 to lug 2 of the Sweep Position control (S-1).

( ) Connect the remaining 150 KΩ (brown-green-yellow) resistor from lug 2 of control F (S-2) to lug 3 of the Sweep Position control (NS).

( ) Connect the 2-1/4" wire from switch lug FA10 to lug 3 of the Sweep Position control (S-2).



Detail 19B

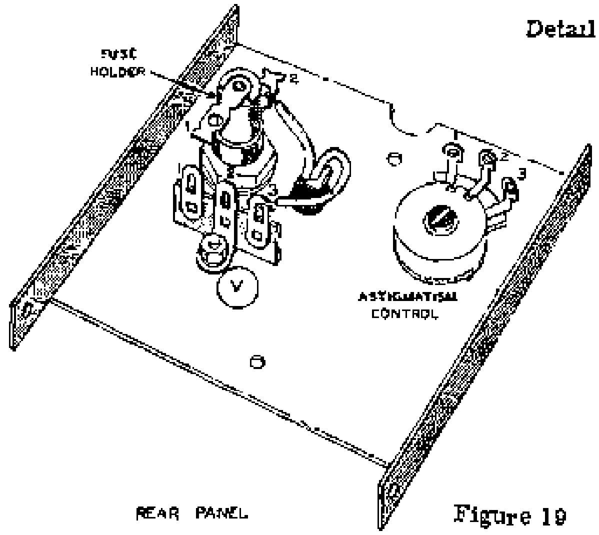
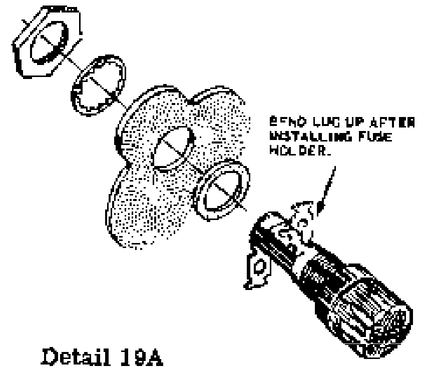


Figure 19



Detail 19A

REAR PANEL MOUNTING AND WIRING

Refer to Figure 19 for the following steps.

(✓) R51. Mount the 500 K antigmatism control (#10-60) on the rear panel.

( ) Install the fuse holder. See Detail 19A.

(✓) Install the line cord, with the strain relief insulator, as shown in Detail 19B.

( ) Mount 3-lug terminal strip V with a 6-32 x 3/8" screw, two #6 lockwashers and a 6-32 nut.

(✓) Connect one line cord lead to lug 2 of the fuse holder (S-1). Connect the other line cord lead to lug 3 of terminal strip V (NS).

Refer to Figure 20 for the following steps.

( ) Install the rear panel on the transformer bracket with 6-32 x 3/8" screws, #6 lockwashers and 6-32 nuts. Leave the panel leaning backwards, as shown in Figure 20, for the following wiring.

(✓) Cut one of the black transformer leads to length and connect it to lug 1 of terminal strip V (NS).

(✓) Cut the other black transformer lead to length and connect it to lug 1 of the fuse holder (S-1).

( ) Locate the two wires of the twisted pair of wires from the front panel. Connect one wire to lug 1 (S-2) and the other wire to lug 3 (S-2) of terminal strip V.

( ) Connect the wire coming from lug 2 of terminal strip Q to lug 1 of control W (S-1).

( ) Connect the high voltage insulated wire coming from lug 8 of the CR tube socket to lug 2 of control W (S-1).

( ) Connect the wire coming from lug 5 of terminal strip R to lug 3 of control W (S-1).

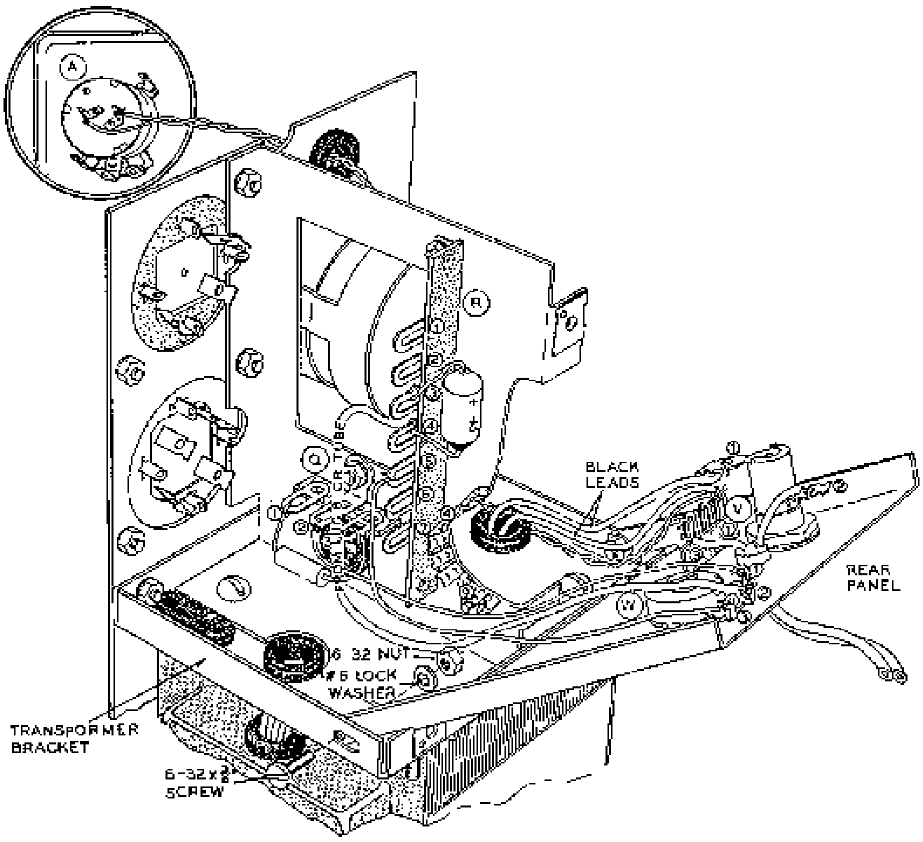


Figure 20

(✓) Fasten the rear panel to the support bracket with 6-32 x 3/8" screws. Tighten the two "hinge" screws.

( ) Referring to Figure 21, prepare the two (one red and one black) test leads as shown.

This completes all of the wiring operations in the assembly of your IO-10 Oscilloscope. Check all connections and see the lead dress is as shown in the wiring figures. Do not attempt to operate it until you have gone through the following TEST AND ADJUSTMENT section.

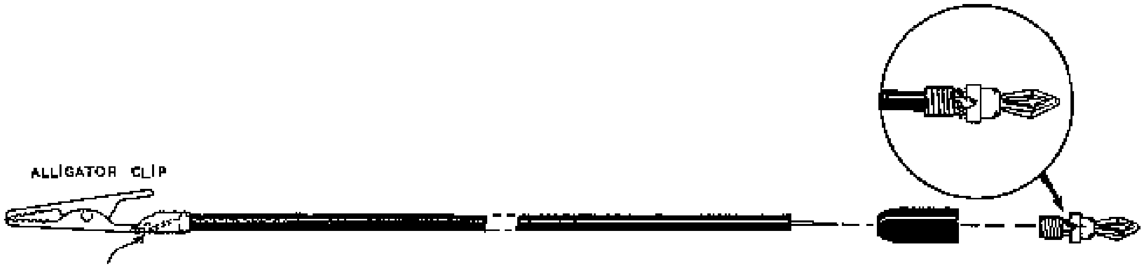


Figure 21

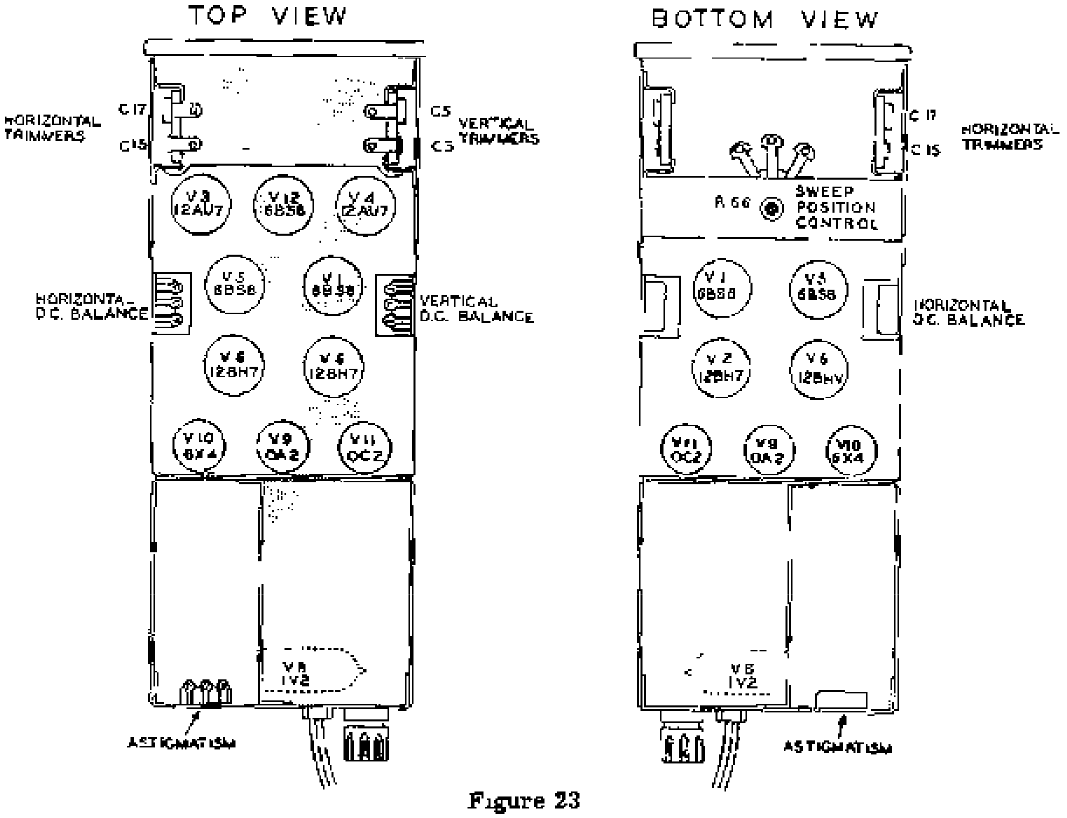


Figure 23

TEST AND ADJUSTMENT

Preliminary Adjustments

( ) Refer to the tube location Figure 23 and install the tubes. Also install one of the fuses in the fuse holder.

IMPORTANT WARNING: TUBES CAN BE DAMAGED WHEN INSTALLING THEM IN THEIR SOCKETS. THEREFORE, USE EXTREME CARE WHEN INSTALLING TUBES AS WE DO NOT GUARANTEE OR REPLACE TUBES BROKEN DURING HANDLING OR INSTALLATION.

NOTE: Figure 23 shows tube and adjustment control locations.

( ) Set the controls and switches as follows:

VERTICAL and HORIZONTAL gain controls.	Minimum
VERTICAL and HORIZONTAL attenuator switches.	AC, X100
FREQUENCY switch.	Horizontal Input
Fine FREQUENCY control.	Full CCW
All other controls and adjustments.	Middle of range

( ) Plug the unit into a source of 105-125 volt 50/60 cycles AC only, and allow 5 minutes for warmup. Note that when power is applied to the unit, the voltage regulator tubes (V9 and V11) should glow with a purplish or orange light inside the tube elements. This is a normal condition. Also, the pilot light will normally not light for 10 to 15 seconds. During this warmup time, advance the INTENSITY control full clockwise and carefully adjust the centering controls until a spot appears on the tube face. If difficulty is encountered in centering the spot, connect a voltmeter between the chassis and 12BH7 plates (V6 and V2). When DC voltage reading is the same on both plates (adjust with centering control) spot will be centered.

NOTE: If this, or any of the following steps, do not have the proper effect, turn the unit OFF immediately and refer to the IN CASE OF DIFFICULTY section on Page 40.

Astigmatism Control

( ) As soon as the spot has been located, position it in the center of the tube face, and reduce the INTENSITY control until it is just visible. Carefully adjust the FOCUS and astigmatism controls in conjunction with each other to obtain the smallest possible spot. The astigmatism control is located on the rear panel bracket.

Vertical DC Balence

( ) Turn the VERTICAL gain control (red knob) slowly clockwise and see if it moves the spot. If it does, return the spot to the original location with the Vertical DC Balance control. Rotate the VERTICAL gain control from minimum to maximum a few times to be sure no further change in spot position occurs.

Horizontal DC Balance

( ) Now turn the HORIZONTAL gain control (red knob) clockwise and see if the spot moves horizontally. If it does, return the spot to its original location with the horizontal DC balance control. Turn the HORIZONTAL gain control back and forth a few times, as in the previous step, to be sure no further change in spot position occurs.

Sweep Positioning Control

( ) Set the FREQUENCY switch to the 5-50 position. Slowly advance the HORIZONTAL gain control (red knob) and observe the trace. It will probably shift to one side as it becomes a short line. Slowly adjust the Sweep Positioning control. When this is properly adjusted, advancing the HORIZONTAL gain control should expand the dot, at the same speed, in both directions.

Now switch the HORIZONTAL Attenuator to AC X10 position, and check the adjustment. This line will be much longer and the adjustment more critical. Slightly readjust the Sweep Positioning control if necessary.

CR Tube Positioning

In the previous steps, the trace may not have been perfectly horizontal. If it was not, correct the condition as follows:

( ) CAUTION: The voltages provided for the CR tube are high enough to be lethal under some conditions. Under NO circumstances attempt to rotate the tube with the power applied to the unit. Observe the position of the trace on the CR tube and estimate how far the CR tube should be turned. Turn off the power and pull the plug. Loosen the clamp at the neck of the CR tube and rotate the tube the proper amount by turning its socket. Do not allow the tube to slide forward and come into contact with the grid screen. If the CR tube is tightly fitted in the shield it may be nessary to swing the rear panel back and/or remove V8, the 1V2 tube. This process may be repeated if the trace is still slightly tilted. Now, carefully tighten the CR tube neck clamp to hold the tube in place. Be sure not to overtighten and break the tube neck. Now, turn the unit on again and check to be sure the trace is horizontal.

Horizontal Attenuator Compensation

( ) Now return both the VERTICAL and HORIZONTAL gain controls to the CCW position and readjust the centering controls (if necessary) to position the beam in the center of the screen. Set the FREQUENCY switch to the INTERNAL SYNC 500-5000 position and the fine FREQUENCY control to the center of its range. Set the VERTICAL Attenuator switch to the AC X1 position, and the HORIZONTAL Attenuator switch to the AC X10 position. Turn the unit OFF and connect a lead between the red vertical input binding post and the center lug of the Sweep Positioning control. Turn the unit ON, and after warmup, adjust the VERTICAL and HORIZONTAL gain controls until a trace similar to Figure 22 appears. Adjust the horizontal attenuator trimmer capacitor nearest the front panel to provide the straightest line.

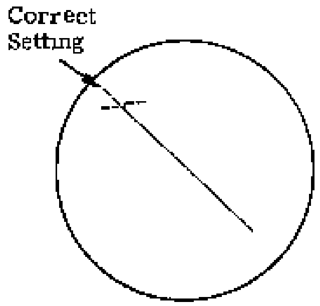


Figure 22

( ) Now set the HORIZONTAL attenuator switch to the AC X100 position and readjust the gain controls to provide a trace similar to Figure 22, as before. This time adjust the horizontal attenuator trimmer farthest from the front panel to provide the straightest line.

Vertical Attenuator Compensation

( ) Return the gain controls to the CCW position and set the HORIZONTAL attenuator switch to the AC X1 position. Set the VERTICAL attenuator switch to the AC X10 position. Again, adjust the gain controls until a trace similar to Figure 22 appears. Adjust the vertical attenuator trimmer capacitor nearest the front panel to provide the straightest line.

( ) Now set the VERTICAL attenuator switch to the AC X100 position and readjust the gain controls to provide a trace similar to Figure 22. This time adjust the vertical attenuator trimmer farthest from the front panel. Now remove the lead.

Sweep Generator Performance Check

( ) Connect a lead from the red vertical input post to lug 5 of tube socket V2. Set the FREQUENCY switch to the internal sync 5-50 position and adjust the HORIZONTAL attenuator and HORIZONTAL gain controls to provide a full screen pattern. Adjust the VERTICAL attenuator and VERTICAL gain controls to provide a trace heighth of 3-4 squares.

Turn the fine FREQUENCY control full CCW. Now slowly rotate this control clockwise until the pattern stops or "syncs" in. There should be at least 12 full cycles on the screen, as 12 cycles of information would be displayed with a sweep frequency of 5 cps (cycles per second). The formula for determining the frequency at which the sweep generator is operating is as follows:

Thus, 60 cps divided by 5 cps sweep frequency equals 12 cycles.

If there are more than 12 cycles, it merely indicates the sweep generator is running at a frequency lower than 5 cps. (This is normal, due to the component tolerances used.)

( ) Now turn the fine FREQUENCY control clockwise until 2 cycles are "locked in." This corresponds to a sweep frequency of 30 cps. The control should be approximately three-quarters of the way full CW.

( ) Switch to the 50-500 sweep frequency range. Turn the fine FREQUENCY control CCW until 1 cycle is displayed. This indicates a 60 cps sweep rate. The fine FREQUENCY control should be nearly all the way CCW. If the performance at all these checkpoints is favorable, you can be reasonably certain that your IO-10 sweep generator is functioning properly.

NOTE: If a variable frequency audio signal generator is available, spot checks can be made, if desired, on the higher frequency sweep ranges as well, using the methods employed in the previous steps.

This completes the adjustment and test of your IO-10. It can now be installed in the cabinet as follows:

( ) Secure the handle with two #10 self-tapping screws. Tighten securely.

( ) Press the small end of one of the rubber feet through each of the four mounting holes in the bottom of the cabinet.

( ) Now slip the unit into the cabinet and secure with two 6-32 x 5/8" binder head screws.

Your IO-10 can now be put into service. Note that access holes have been provided in the cabinet so that all internal adjustments can be reached without removing the cabinet. This greatly simplifies the periodic recalibration normally required in the maintenance of the IO-10.

OPERATION

GENERAL CONSIDERATIONS

Heat

This unit, like most electronic equipment, generates a certain amount of heat. Be sure the ventilation openings on the sides of the cabinet are not obstructed in any way. It is entirely normal for the outside of the cabinet to become quite warm to the touch after a few minutes of operation.

Operating Location

Although the CR tube is shielded to prevent trace distortion due to magnetic fields, it is possible that some trace distortion due to a very high field may still occur. The shield will certainly reduce these effects, but may not entirely eliminate them, and if this appears to be a problem, the simplest remedy is usually to find a location for the scope farther from the offending equipment.

Voltage Regulation

If the unit is turned off and then is immediately turned back on, the OC2 voltage regulator tube may not light. This would change the power supply voltage and cause the trace to disappear. To prevent this condition, always leave the unit off for at least thirty seconds before turning it back on.

VERTICAL AND HORIZONTAL AMPLIFIERS

Gain Controls

To prevent overloading the input stages in the amplifier, always reduce a large amplitude signal with the attenuator switch and not the variable gain control. Try to keep the variable gain control setting as high as possible to avoid this difficulty.

General

When using DC coupling on either or both amplifiers, remember that it may not be possible to see a small signal superimposed on a high DC voltage. This is entirely normal and will be better understood if you remember that the DC component of the signal will be amplified by the same amount as the signal voltage. A shift in centering will also result with changes in gain and/or attenuator settings. This, too, is normal as these controls affect the gain of the amplifier.

SWEEP GENERATOR

Internal-External Sync

In the INTernal SYNC positions of the FREQUENCY control, a portion of the input signal is taken from the vertical amplifier and applied to the sweep multivibrator. This is done to hold the sweep generator at the same frequency or at a submultiple of the input signal.

In the EXTernal SYNC positions, a portion of the input signal may be applied directly to the EXT SYNC binding post, allowing external control for more or less sync signal.

Fine FREQUENCY Control

After the correct sweep frequency range has been selected, only the fine FREQUENCY control has to be adjusted to obtain a stable pattern. Form the habit of setting the fine FREQUENCY control with a small vertical signal (1-2 squares high). This will assure best performance of the sync circuit during changing signal conditions.

APPLICATIONS

The oscilloscope is a very versatile instrument. Properly used, there is almost no limit to the number and type of measurements it can provide.

To actually list the wide variety of applications in which your IO-10 Oscilloscope may be used would be beyond the scope of this manual. However, several common applications are listed below:

Checking the output voltage and frequency of an oscillator circuit.

Checking the frequency response of an amplifier (either stage by stage, or as a complete unit).

Troubleshooting radios, TV sets, hi-fi equipment.

Using with a computer as a read-out device.

Measuring DC voltage.

SUGGESTED READING

More information on oscilloscope applications will be found in the following reading material:

ZWICK, THE OSCILLOSCOPE - Gernsback Publications, New York.

RUITER, OSCILLOSCOPES AND THEIR USES - Murray Hill Books, Inc., New York.

PARR, THE CATHODE RAY TUBE - Chapman and Hall, London.

RIDER and USLAN, ENCYCLOPEDIA OF CATHODE RAY OSCILLOSCOPES - Rider, New York.

BLY, GUIDE TO CATHODE RAY PATTERNS - John Wiley and Sons, New York.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair, malfunction due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.
3. Check to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly.
4. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.
5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with a HEATHKIT* Vacuum Tube Voltmeter. Voltages may vary 10% due to line voltage variations.

8. A review of the Circuit Description and Block Diagrams will prove helpful in indicating where to look for trouble.

TROUBLESHOOTING CHART	
Trouble	Suggested Test
Tube filaments do not light	Check fuse - check filament voltage.
No spot or trace	Remove vertical output tubes, if spot appears check vertical circuit voltage and tubes. Remove horizontal output tubes - if spot appears check horizontal circuit voltage and tubes. Check for high voltage.
No vertical deflection	Check vertical tubes and voltages.
No horizontal sweep	Check horizontal tubes and voltages.
A tube filament does not light	Check tube.
No B+	Check fuse. Check V9 and V10. Check for open resistors, shorted capacitors or defective tubes.
No B-	Check fuse. Check silicon rectifier and V11. Check for open resistors or shorted capacitors.
Poor focusing	Check V8 - check high voltage bleeder resistors R54, R55, R56 and R57. Check C19.
Fuse blows when switch is turned on	6X4 and OC2 tubes interchanged.

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under "IN CASE OF DIFFICULTY." Possibly it will not be necessary to write.
2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.
3. Report fully on the results obtained when testing the unit initially and when following the suggestions under "IN CASE OF DIFFICULTY." Be as specific as possible and include voltage readings if test equipment is available.
4. Identify the kit model number and date of purchase if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1.)
5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. (The automatic letter opener sometimes cuts through the letter, hence the suggestion to print the name and address twice.) In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed instrument to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although you may find charges for local service somewhat higher than for factory service, the amount of increase is usually offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company, however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge, however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipmant will be returned NOT repaired.

For information regarding modification of **HEATHKIT** equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with **HEATHKIT** products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrumant operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.

B. Identify the type and model number of kit in which it is used.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacemant policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrumant must be returned for service, these instructions should be carefully followed.

ATTACH A TAG TO THE EQUIPMENT BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the addrees on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by insured parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

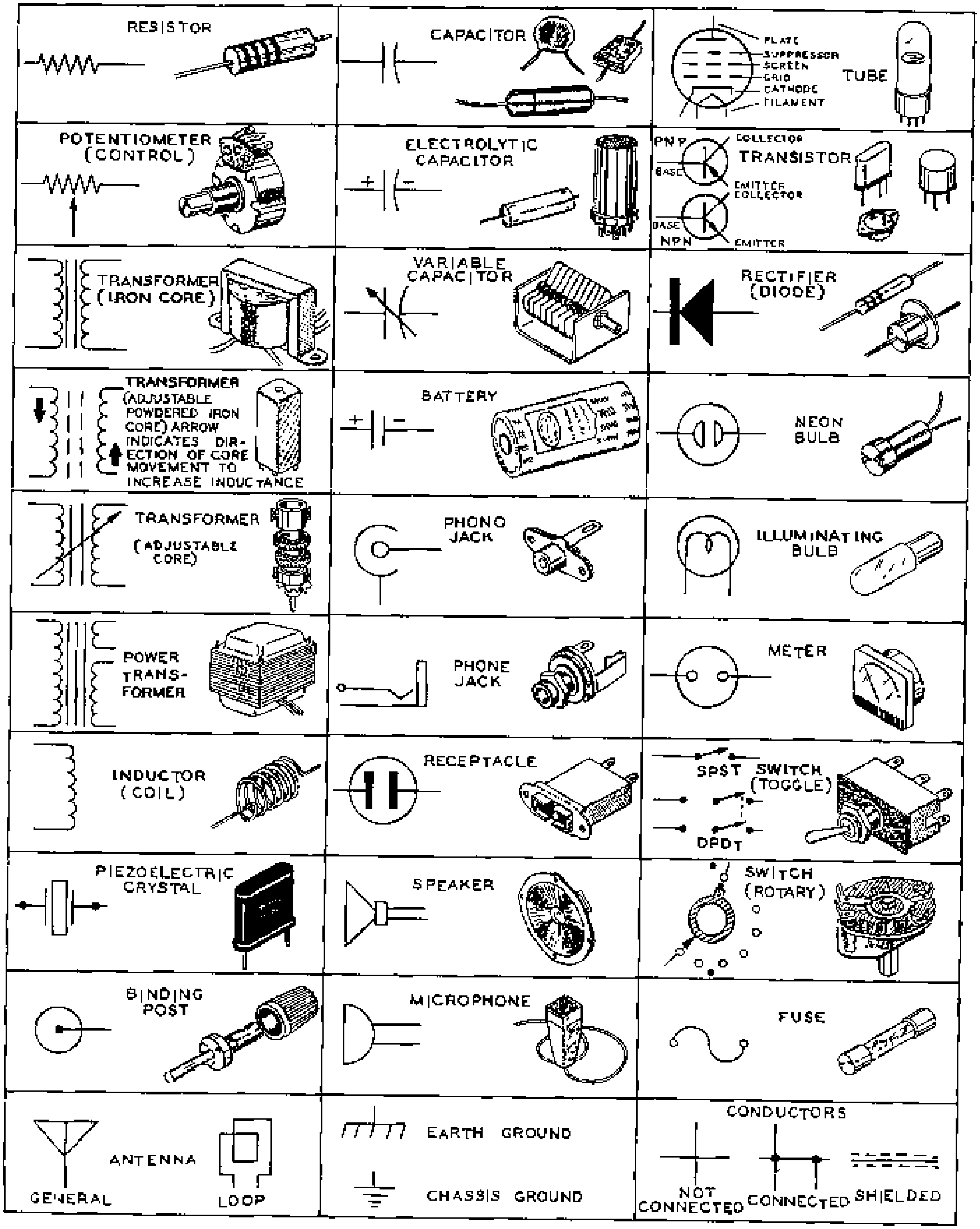
Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment

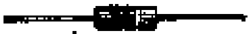
NOTE The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used

HEATH COMPANY

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.

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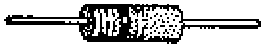
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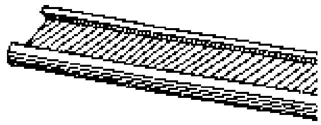
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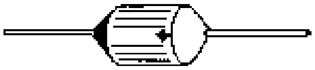
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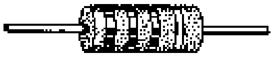
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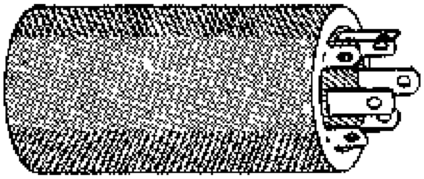
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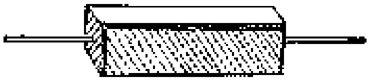
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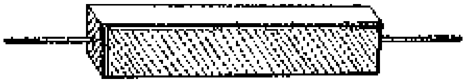
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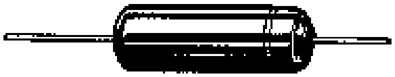
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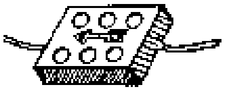
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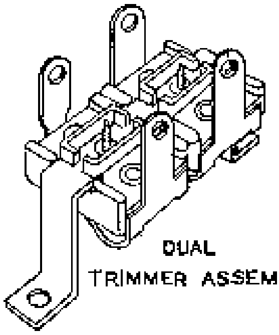
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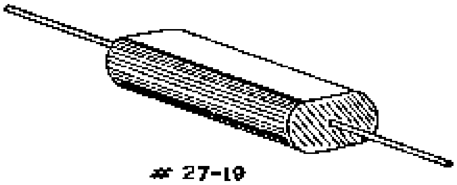
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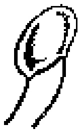
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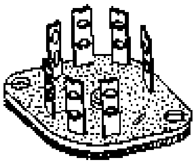
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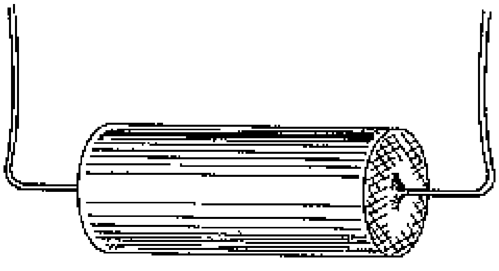
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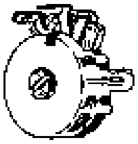
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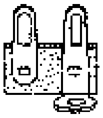
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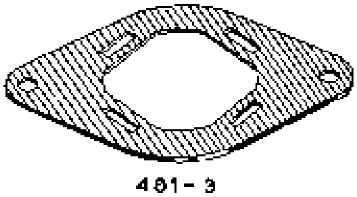
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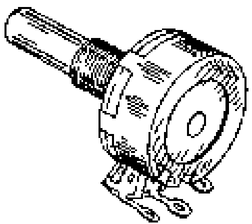
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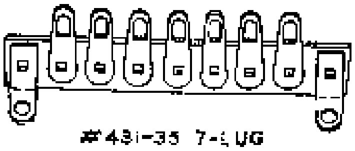
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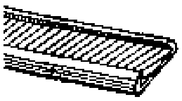
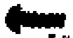
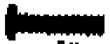
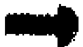




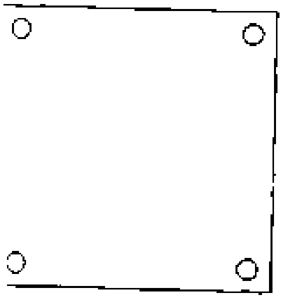
3-48 X $\frac{5}{16}$" RHMS



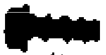
6-32 X $\frac{3}{8}$" BHMS.



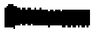
6-32 X $\frac{3}{8}$" RHMS.



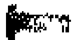
GRATICULE



#10 X $\frac{1}{2}$" SELF
TAPPING SCREW

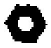


3-48 X $\frac{1}{2}$" FHMS

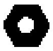


6-32 X $\frac{3}{8}$" [illegible]MS

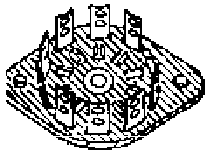
3-48 NUT



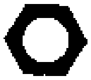
6-32 NUT



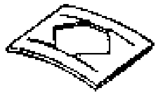
6-32 NUT



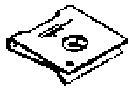
#434-16 9-PIN
WAFER SOCKET



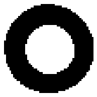
CONTROL NUT



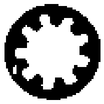
#252-32
SPEED NUT



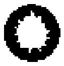
#252-22
SPEED NUT



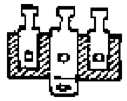
CONTROL FLAT
WASHER



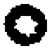
CONTROL
LOCKWASHER



#8 LOCKWASHER

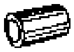


#431-38 3-LUG
ERMINAL STRIP

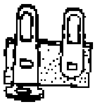


#6 LOCKWASHER

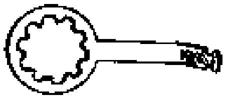
#3 LOCKWASHER



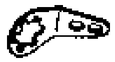
SPACER



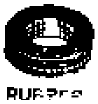
431-16 2-LUG
RMINAL STRIP



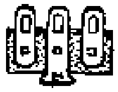
CONTROL
SOLDER LUG



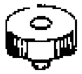
#6 SOLDER LUG



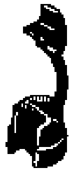
RUBBER
GROMMET



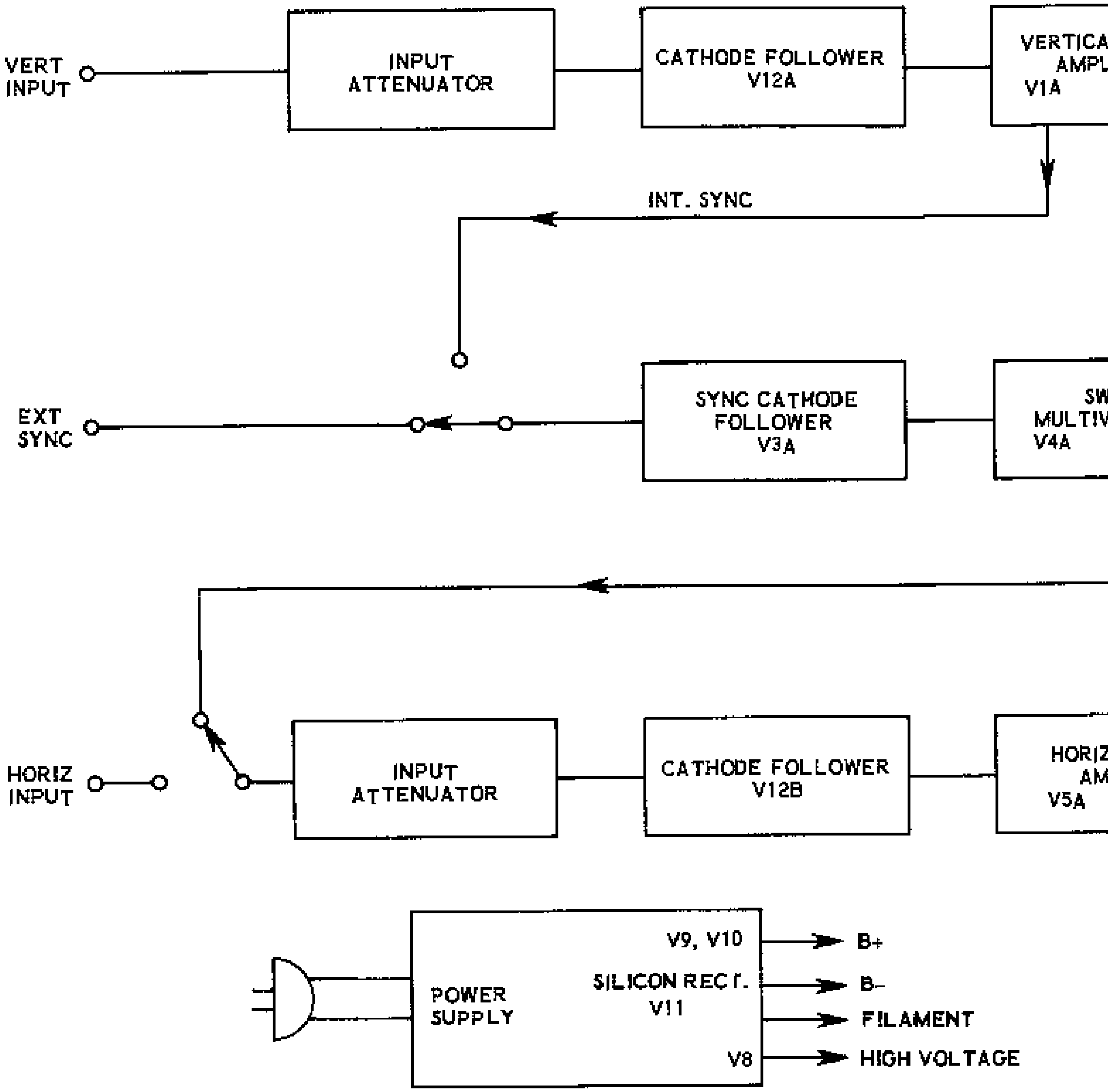
431-10 3-LUG
ERMINAL STRIP



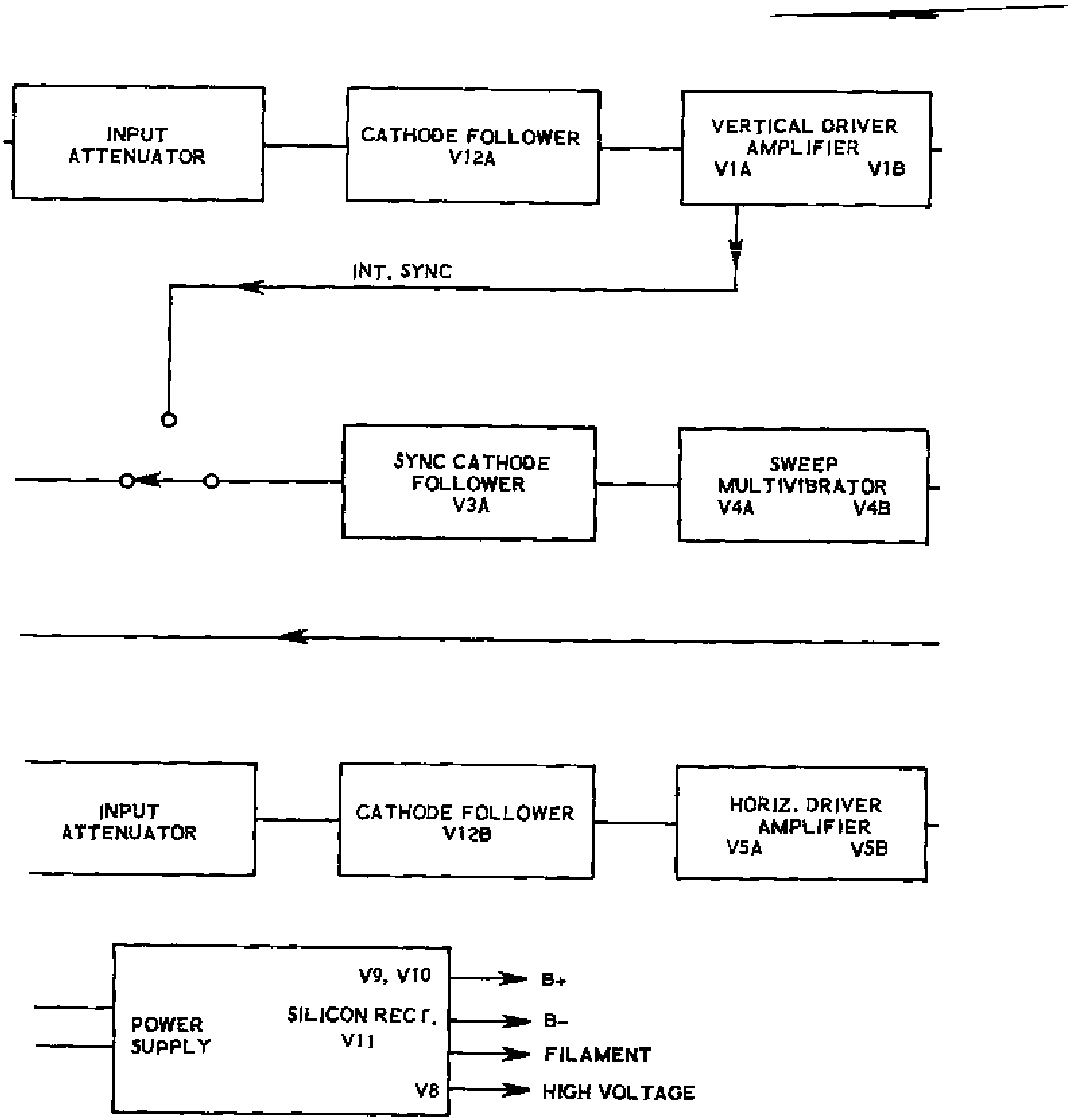
#75-17
BINDING POST
INSULATOR



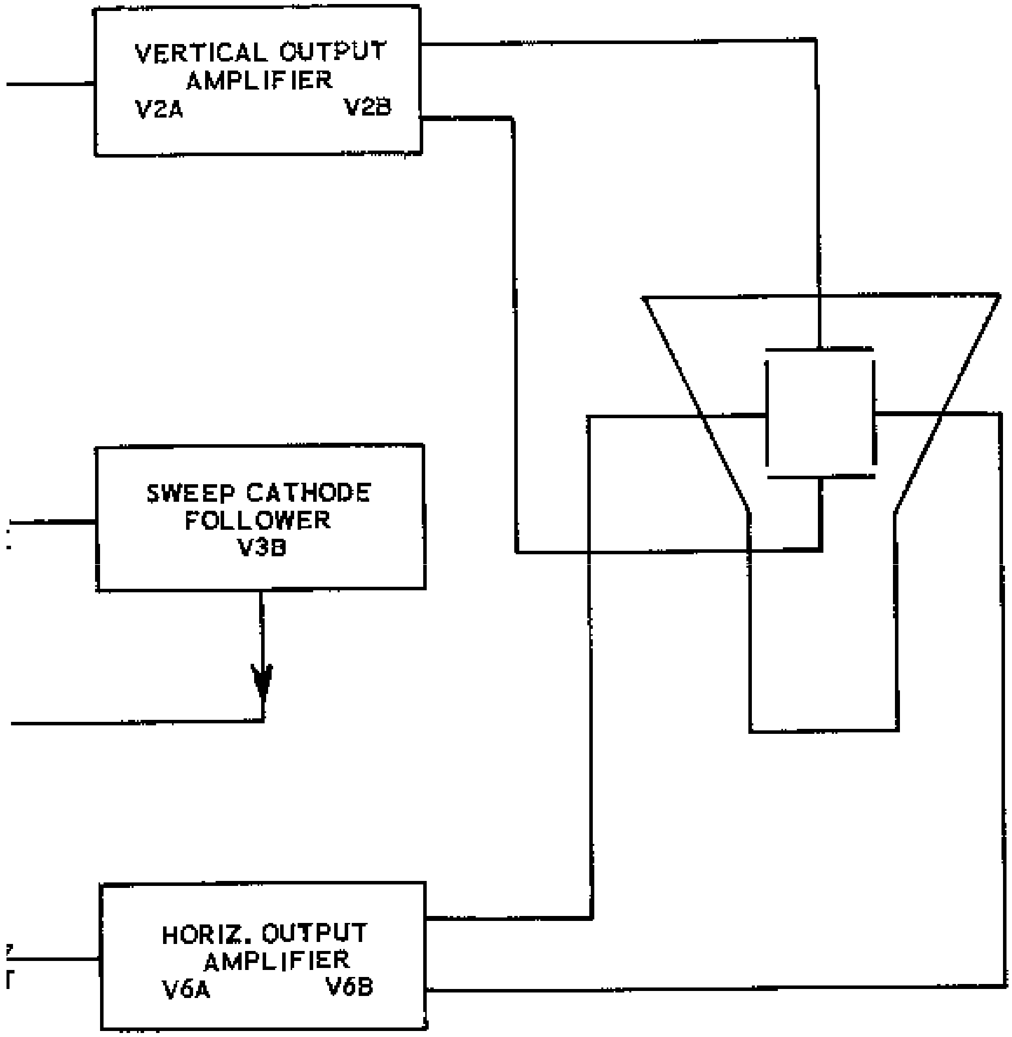
#75-2A
LINE CORD
STRAIN RELIEF

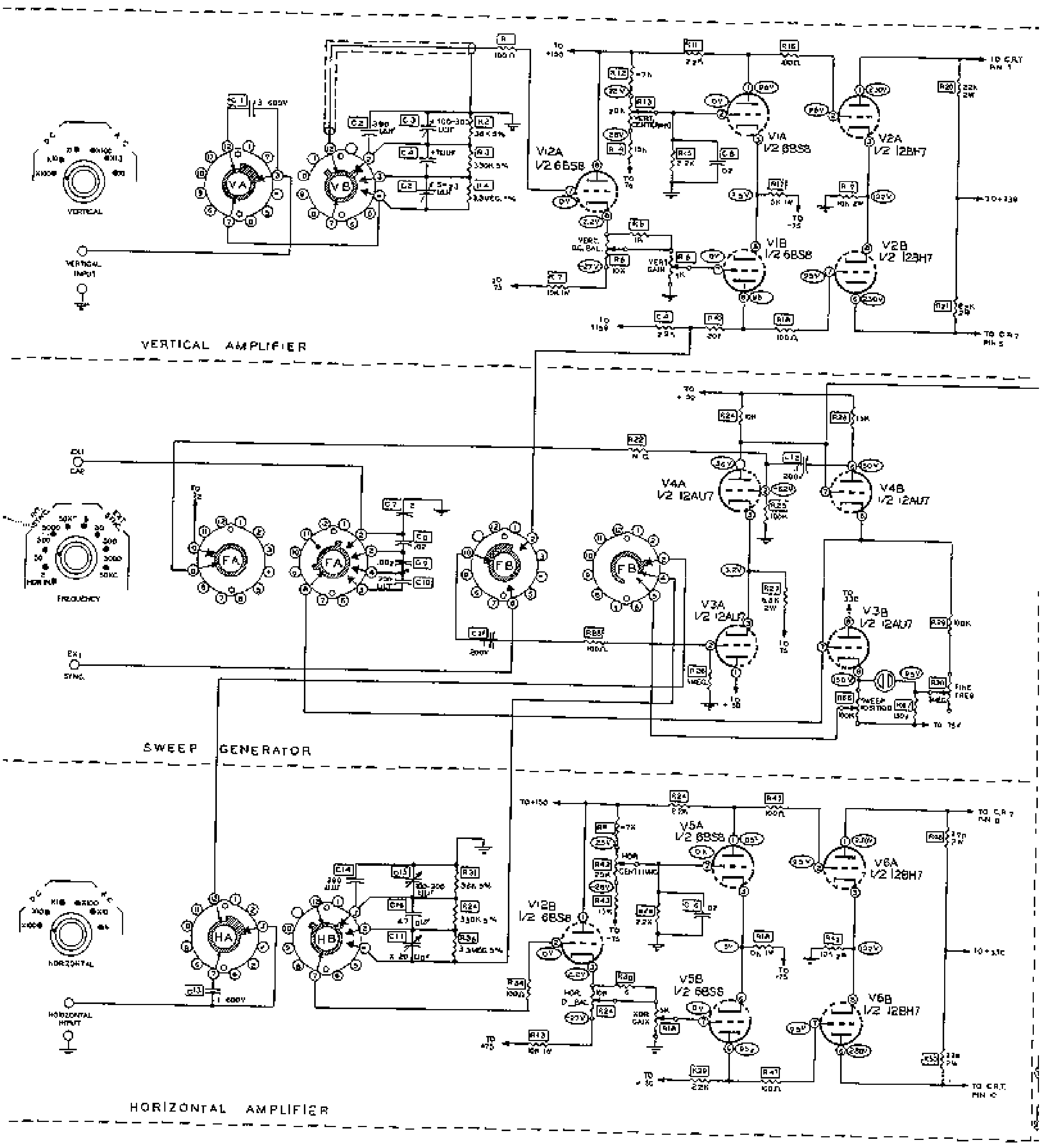

VERT INPUT
INPUT ATTENUATOR
CATHODE FOLLOWER V12A
VERTICA AMPL V1A
INT. SYNC
EXT SYNC
SYNC CATHODE FOLLOWER V3A
SW MULTIV V4A
HORIZ INPUT
INPUT ATTENUATOR
CATHODE FOLLOWER V12B
HORIZ AM V5A
POWER SUPPLY
V9, V10
SILICON RECT. V11
V8
B+
B-
FILAMENT
HIGH VOLTAGE

BLOCK DIA



BLOCK DIAGRAM


VERTICAL OUTPUT AMPLIFIER
V2A
V2B
SWEEP CATHODE FOLLOWER
V3B
HORIZ. OUTPUT AMPLIFIER
V6A
V6B

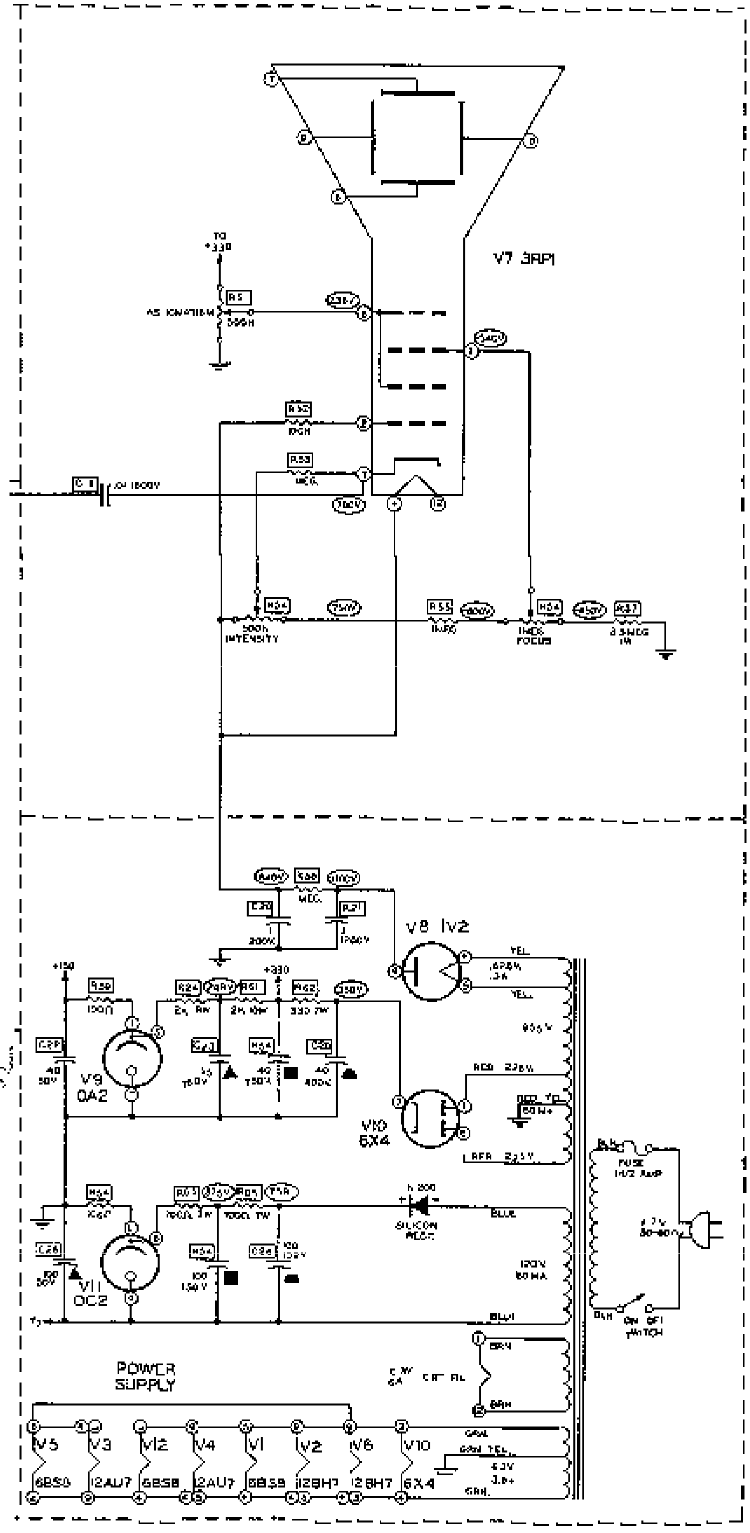


HEATHKIT DAYSTROM

INSTRUMENT OSCILLOSCOPE

MODEL IO-10

SWITCHES ARE INT
SWITCHES ARE VIE
ALL RESISTORS
ALL RESISTOR VAL
ALL CAPACITOR VA
ALL VOLTAGES
EXCEPT AC VOLT
READINGS WERE T



4 THE POSITIONS SHOWN BY THE FRONT PANEL MARKINGS

IEWED FROM THE FRONT

IRE 1/2 WATT UNLESS SHOWN OTHERWISE

ALUES ARE IN OHMS (K 1000 OHMS, MEG. = 1,000,000 OHMS

VALUES ARE IN µF UNLESS OTHERWISE SHOWN.

HE FROM POINT INDICATED TO CHASSIS GROUND
TAGES ON POWER TRANSFORMER WINDINGS)
TAKEN WITH AN 11 MEGOHM INPUT VTVM.

RESISTOR AND CAPACITOR COLOR CODES

RESISTORS

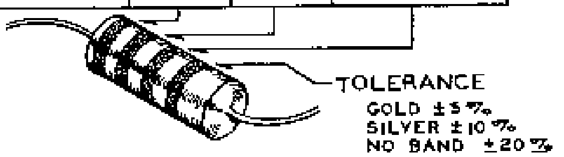
The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit, the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of ±5% or ±10% respectively. The absence of a fourth band indicates a tolerance of ±20%.

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

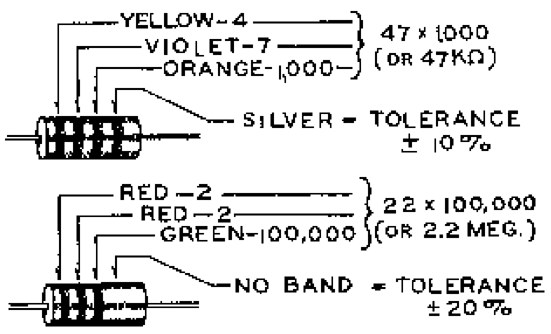
The color code chart and examples which follow provide the information required to identify color coded resistors

CODE

COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01



EXAMPLES



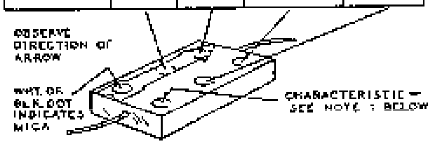
CAPACITORS

Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

MICA

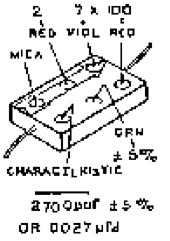
CODE

COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER	TOLER.%
BLACK	0	0	1	±20
BROWN	1	1	10	—
RED	2	2	100	±2
ORANGE	3	3	1000	±3
YELLOW	4	4	10,000	—
GREEN	5	5	—	±5
BLUE	6	6	—	—
VIOLET	7	7	—	—
GRAY	8	8	—	—
WHITE	9	9	—	—
GOLD	-	-	.1	—
SILVER	-	-	.01	±10


OBSERVE DIRECTION OF ARROW
WHT. OR BLK. DOT INDICATES MICA
CHARACTERISTIC — SEE NOTE 1 BELOW

(VALUE IN μμf—SEE NOTE 3 BELOW)

EXAMPLE

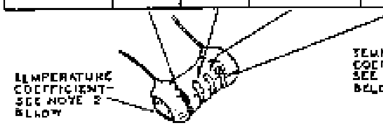


TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.

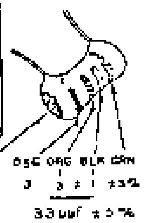
CODE

COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER	TOLER. % [illegible]	TOLER. % [illegible]
BLACK	0	0	1	±20	±20
BROWN	1	1	10	±0.1	±1
RED	2	2	100	—	±2
ORANGE	3	3	1,000	—	±2.5
YELLOW	4	4	10,000	—	—
GREEN	5	5	—	±0.5	±5
BLUE	6	6	—	—	—
VIOLET	7	7	—	—	—
GRAY	8	8	—	±0.25	—
WHITE	9	9	—	±1.0	±10


TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW
TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW

(VALUE IN μμf—SEE NOTE 3 BELOW)

EXAMPLE



NOTES.

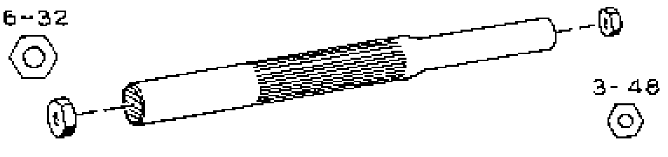
1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association.)

2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μfd (micro-farad, .000001 farad) and μμf (micro-micro-farad, .000001 μfd); therefore 1,000 μμf = .001 μfd, 1,000,000 μμf = 1 μfd.

USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut



HEATH COMPANY

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THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

595-346

LITHO IN U.S.